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Flap Effectiveness on Subsonic Longitudinal Aerodynamic Characteristics of a Modified Arrow Wing

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SUMMARY

An investigation of the subsonic longitudinal aerodynamic characteristics of a modified arrow-wing model was conducted in the Langley 4- by 7-Meter Tunnel. The results of the investigation indicated that deflecting the leading edge and trailing edge in combination could promote an attached-flow condition at the wing leading edge. Also, significant drag due to lift improvements resulted from combined leading- and trailing-edge flap deflections. The deflection of the trailing-edge flaps produced an increase in the upwash angle, which caused the leading-edge vortex to form at a lower angle of attack. Leading-edge suction could be maximized over the complete lift-coefficient range by scheduling a combination of leading- and trailing-edge flap deflections.

INTRODUCTION

Highly maneuverable, supersonic-cruise fighter airplanes are under study by the National Aeronautics and Space Administration (NASA), Department of Defense (DOD), and the aircraft industry. To aid in this study, the NASA Langley Research Center has built a wind-tunnel model to investigate the subsonic aerodynamic characteristics of a highly swept wing representative of such a fighter configuration. The planform of this configuration is similar to that of the supersonic-cruise transport airplanes that have been studied at Langley. Several investigations have been performed on the subsonic aerodynamic characteristics of this transport configuration (see refs. 1 to 3), and two of these investigations are on the effectiveness of leading- and trailing-edge flaps. The results of these investigations helped in the design of the present modified arrow wing, which will be explained later in this report.

The arrow-wing model was tested in the Langley 4- by 7-Meter Tunnel to obtain data on the effectiveness of the leading- and trailing-edge flap deflections in achieving attached flow over the leading edge. This investigation addressed the effectiveness of the flap deflections on the longitudinal aerodynamic characteristics, and the problem of trimming for this configuration was not considered. The investigation included leading-edge deflections from 0° to 60° and trailing-edge deflections from 0° to 30° at angles of attack from -4° to 24° at a Mach number of 0.20.

SYMBOLS

All data have been reduced to coefficient form and are presented in the stability-axis system. Computer symbols used are given in parentheses.

A		aspect ratio
C_D	(CD)	drag coefficient, Drag/qS_{ref}
$C_{D,i}$		induced drag coefficient
$C_{D,o}$		drag coefficient at zero lift

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C_L	(CL)	lift coefficient, Lift/qS_{ref}
C_{L_α}		lift-curve slope, $dC_L/d\alpha$
C_m	(CM)	pitching-moment coefficient, $\mathrm{Pitching\ moment}/qS_{ref}\bar{c}$
$\bar{c}$		wing mean aerodynamic chord, 3.011 ft
L/D	(L/D)	lift-drag ratio, C_L/C_D
M	(MACH)	Mach number
q	(Q)	free-stream dynamic pressure, $\mathrm{lbf/ft^2}$
s		leading-edge suction parameter, percent (see eq. (3))
S_{ref}		reference wing area, 10.422 ft^2
u		velocity in x-direction, ft/sec
w		velocity in z-direction, ft/sec
x,z		coordinate pointing toward the nose and coordinate perpendicular to the x coordinate, respectively
α	(ALPHA)	angle of attack, deg
δ		flap deflection, normal to hinge line (positive, down; negative, up), deg

Subscripts:

A	attached flow
LE	leading edge
S	separated flow
TE	trailing edge

Abbreviations:

BL		butt line
BS		body station
PT	(PT)	test-point number

MODEL DESCRIPTION AND TEST CONDITIONS

The leading edge of the modified arrow wing has an inboard sweep of 70° and an outboard sweep of 48.8°. (See fig. 1.) The airfoil section is an NACA 0004, and the wing has no twist. There are seven leading-edge flap segments per semispan, which deflect normal to the leading edge. The maximum deflection of the inboard segment

is 20°. The maximum deflection of the next three segments increases at 10° intervals (i.e., 30°, 40°, and 50°); the last three outboard segments could be deflected up to 60°. An example of the leading-edge flap-deflection terminology is $\delta_{LE} = 40°$, whereby the actual leading-edge flap segments are deflected from inboard to outboard in the following manner: 20°, 30°, 40°, 40°, 40°, 40°, and 40°. The wing also has three trailing-edge flap segments per semispan. The trailing-edge flap segments have a maximum deflection of 30°. The leading- and trailing-edge flap segments can be deflected independently of one another. (See table I for the wing geometry and both fig. 2 and table II for the flap-deflection terminology used in this report.)

A high-fineness-ratio fuselage was used to fair around the strain-gage balance and other instrumentation. (See fig. 3.) The fuselage geometry is given in table III by the body station (BS) and its appropriate circular cross-sectional area. The forces and moments were measured with a six-component strain-gage balance mounted inside the model. The tests were conducted at a dynamic pressure of 60 lbf/ft^2, which resulted in a Reynolds number of 1.5×10^6 per foot at a corresponding Mach number M of 0.20, and the angle of attack ranged from -4° to 24°.

DESIGN OF LEADING-EDGE FLAP DEFLECTION

In an effort to maintain attached flow on the leading edge of a highly swept wing, a series of leading-edge flaps were installed which could be drooped at various angles as mentioned in the model-description section. The droop angles were chosen so that the leading-edge flap would be approximately aligned with the flow upwash angle $(w/u + \alpha)$ near the wing leading edge. By using the vortex-lattice method NARUVLE (North American Rockwell's Unified Vortex Lattice Extended Program described in the theoretical-analysis section of ref. 4), an initial off-body velocity distribution was computed for the wing planform at $\alpha = 10°$ and $\delta_{TE} = 0°$ and 30° with $\delta_{LE} = 0°$. The leading-edge droop was then set by the upwash angle indicated by the initial off-body velocity distribution and used to predict the new off-body velocity points with $\alpha = 10°$ and $\delta_{TE} = 0°$ and 30°. (The leading-edge deflection was normal to the free stream during this analysis, although the wind-tunnel model had leading-edge deflections normal to the leading edge.) This procedure was repeated until a converged solution (i.e., no change in velocity distribution or leading-edge droop) was achieved.

The final upwash angles or leading-edge droop angles for both $\delta_{TE} = 0°$ and 30° are shown in figure 4. These continuous droop distributions were then approximated by the seven discrete flap elements on the wing leading edge. The maximum deflection of seven leading-edge flaps was chosen to approximate the maximum predicted upwash angle at the midpoint of the flap element.

PRESENTATION OF RESULTS

Table IV identifies the leading- and trailing-edge flap configurations of the wing with the corresponding run number used in the wind-tunnel test; the longitudinal aerodynamic characteristics for the model are given in table V. Some longitudinal aerodynamic results are presented as follows:

	Figure
Effect of leading-edge deflections:	
$\delta_{TE} = 0°$	5
$\delta_{TE} = 20°$	6

DISCUSSION

Experimental Results

Effect of wing leading-edge flap deflections.- The longitudinal aerodynamic characteristics at $\delta_{TE} = 0°$ with various leading-edge flap deflections are shown in figure 5. The lift coefficients at angles of attack below 6° are not appreciably affected by the various leading-edge flap deflections. Also, at these small angles of attack and low lift coefficients, the pitching moment is nearly zero, but it does have a slightly negative slope. In addition, the drag polar indicates a slight increase in $C_{D,o}$ with deflected leading edges. This is caused by the separation of the lower surface flow at low angles of attack because of the leading-edge flap deflection. At a moderate lift coefficient ($0.3 < C_L < 0.6$), the drag coefficient decreases as the leading-edge deflections increase, which indicates that the deflected leading edge is now carrying some leading-edge suction force.

At higher angles of attack ($\alpha > 8°$), the data indicate increases in lift coefficient as the leading-edge vortex forms when the leading edge is undeflected. The vortex-lift increase or increment diminishes as the leading-edge flap deflection increases. A nose-up or unstable pitching moment begins at $\alpha \approx 16°$. This nose-up moment is due to the onset of flow separation in the wing-tip region while the inboard region is still maintaining attached flow. (See ref. 5.) Although the pitching-moment coefficient is reduced as the leading-edge flap is deflected, the pitching-moment slope still indicates an unstable pitching moment at $\alpha > 16°$ as shown in figure 5.

The longitudinal aerodynamic characteristics at $\delta_{TE} = 20°$ for various leading-edge flap deflections are shown in figure 6. Comparison of the data of figure 5 ($\delta_{TE} = 0°$) with the data of figure 6 ($\delta_{TE} = 20°$) shows that the 20° trailing-edge flap deflection increased the lift coefficient by about 0.3 and produced a nose-down pitching moment of about 0.11 because of a trailing-edge deflection. Also, the leading-edge vortex began at a lower angle of attack for the undeflected leading edge because of the increased upwash angle induced by the trailing-edge deflection.

To evaluate the effectiveness of the leading-edge deflections better, figures 5 and 6 also present two theoretical drag polars. These polars represent the planar-wing minimum induced drag and the drag with full leading-edge separation with no subsequent flow reattachment. This evaluation is similar to the ones performed in references 1, 2, 3, and 6. The definitions of these drag polars are

$$C_{D,A} = C_{D,o} + C_L^2/\pi A \tag{1}$$

for minimum induced drag or fully attached flow and

$$C_{D,S} = C_{D,o} + C_L \tan \alpha \tag{2}$$

for full separated flow with no leading-edge suction. The value of drag coefficient at zero lift $C_{D,o}$ for this configuration is 0.0021. The value of $C_{D,o}$ is obtained at the C_D intercept of a plot of C_D against C_L^2 for an undeflected wing. Equations (1) and (2) are valid for a wing with no twist and no camber and are used as a quantitative evaluator of the effectiveness of the leading-edge flap deflections. The leading-edge suction parameter S is used as this evaluator and is fined as

$$S = \frac{C_{D,S} - C_D}{C_{D,S} - C_{D,A}} \times 100 = \frac{C_{D,o} + C_L \tan \alpha - C_D}{C_L \tan \alpha - C_L^2/\pi A} \times 100 \qquad (3)$$

where C_D and C_L are measured lift and drag coefficients, respectively. For the theoretical drag-polar calculations ($C_{D,A}$ and $C_{D,S}$), the value of α is replaced by C_L/C_{L_α} where C_{L_α} is determined experimentally to be 0.037 (for the linear region of C_L against α for an undeflected wing), which agrees with theoretical results from the NARUVLE vortex-lattice program. The leading-edge suction parameter is expressed in percent of leading-edge suction so that the minimum induced drag or full suction corresponds to $S = 100$ percent and full leading-edge separation with no suction corresponds to $S = 0$ percent. (See ref. 6 for an explanation of the leading-edge suction parameter.)

Figure 10 presents the variation of leading-edge suction parameter S with C_L for various leading-edge deflections with $\delta_{TE} = 0°$. At low lift coefficients ($0.2 < C_L < 0.4$), the suction parameter increases with increasing leading-edge deflections until a deflection of $\delta_{LE} = 20°$ is reached. With higher deflections, the suction parameter decreases because of overdeflection of the leading edge, which causes flow separation on the lower surface. This increase in S is also true at higher lift coefficients ($C_L > 0.4$). The highest suction parameter with an undeflected trailing edge is $S = 66.6$ percent at $\delta_{LE} = 20°$ and $C_L = 0.31$. This value of lift coefficient may be small for approach or maneuver conditions; a more appropriate value is about 0.6. At this lift coefficient, the maximum suction-parameter value is $S = 63$ percent at $\delta_{LE} = 40°$.

Effect of wing trailing-edge flap deflections.- The longitudinal aerodynamic characteristics with varying trailing-edge deflections are presented in figure 7 for $\delta_{LE} = 0°$, in figure 8 for $\delta_{LE} = 20°$, and in figure 9 for $\delta_{LE} = 60°$. In these three configurations, the data indicate the expected increases in lift coefficient and the pitching-moment coefficient becomes more negative with each trailing-edge deflection. As the deflection of the trailing edge increases, a constant lift coefficient can be achieved at a lower angle of attack. For this situation, where the wing is operating near the zero suction curve ($C_{D,i} = C_L \tan \alpha$), the angle of attack is the dominant term and the induced drag coefficient is reduced. Therefore, the drag polar shows significant improvement at higher lift coefficients as the flap deflection is increased. Also, the lift coefficient increases proportionally to the trailing-edge flap deflection for all three configurations until $\delta_{TE} = 30°$. At this flap deflection, the flow over the flap probably separates, thus causing a diminished lift-coefficient increase. As mentioned in the previous section, the increase in leading-edge flap deflection causes the vortex lift to diminish for all trailing-edge flap deflections (i.e., C_{L_α} is more linear).

The effect of the leading-edge flap deflection on the leading-edge suction parameter for $\delta_{TE} = 10°$, 20°, and 30° is shown in figures 11, 12, and 13, respectively. As in figure 10 where $\delta_{TE} = 0°$, the suction parameter increases as the leading-edge flap deflections are increased until a maximum is reached; then, the suction parameter decreases with further increases in leading-edge deflections. The maximum suction-parameter value for $\delta_{TE} = 10°$ is $S = 83.9$ percent at $C_L = 0.47$ with $\delta_{LE} = 20°$; for $\delta_{TE} = 20°$, it is $S = 86.6$ percent at $C_L = 0.61$ with $\delta_{LE} = 30°$; and for $\delta_{TE} = 30°$, it is $S = 83.6$ percent at $C_L = 0.79$ with $\delta_{LE} = 30°$. Also, note that as the trailing-edge flap deflection increases, the suction-parameter curves shift to higher lift coefficients and show a large leading-edge suction value as shown in figures 10 and 11 to 13.

Effect of combined leading- and trailing-edge flap deflections.- The maximum values of the suction parameter at various leading- and trailing-edge flap deflections are shown in figure 14. These values are from the peak numbers from figures 10 and 11 to 13. Figure 14 is, therefore, an envelope-type curve which presents the maximum leading-edge suction for a combination of leading- and trailing-edge flap deflections over a range of lift coefficients (i.e., higher leading-edge suction than for fixed flap deflections). As lift coefficient increases, the maximum value of S is about 86.6 percent at $C_L \approx 0.61$ and decreases below 80 percent at $C_L > 1.0$, which shows the difficulty in maintaining attached flow at the high angles of attack required for high lift. For an approach or maneuvering configuration, $C_L = 0.6$ and the maximum value of S is about 86 percent at $\delta_{LE} = 20°$ and $\delta_{TE} = 20°$. Figure 15 presents the effect of different leading- and trailing-edge flap combinations on L/D at specific lift coefficients. The effect of the leading-edge flap deflection on L/D diminishes as lift coefficient increases. Also, as lift coefficient increases, the peak L/D value shifts to a higher trailing-edge deflection. Comparing the peak leading-edge suction values of figures 10 and 11 to 13 with the peak values of L/D of figure 15 shows that the best leading-edge deflection is the same in both peak S values and peak L/D values at a specific lift coefficient. The best trailing-edge flap deflection for the peak S values also occurs at the peak L/D values.

At the large leading-edge flap deflections ($\delta_{LE} > 20°$), the leading edge becomes stepped. The stepped segments of the leading edge cause some of the flow to separate. In order to determine the effect of the stepped leading edge on maintaining attached flow, a comparison is presented in figure 16 of a faired and unfaired leading edge plotted against leading-edge suction parameter. The fairing causes the leading edge to be a smooth flap rather than a stepped flap. There is an increase in the leading-edge suction parameter from the unfaired to the faired leading edge, which indicates that the stepped leading edge is causing some flow separation; at a lift coefficient of 0.6, an improvement is obtained from $S = 52.8$ to 56.5 percent by fairing the leading edge.

Theoretical Analysis

A preliminary theoretical analysis of the wing was conducted by using three computer programs: (1) NARUVLE (see ref. 4); (2) a vortex-lattice program with vortex-flow computation using the leading-edge suction analogy (see refs. 7 and 8); and (3) a surface-paneling program (PANAIR pilot code) (see ref. 9). Figure 17 compares the experimental data with the results of the three theoretical programs for the undeflected leading- and trailing-edge case. The PANAIR pilot code and NARUVLE program are attached inviscid-flow programs and do not account for the separated vortex-flow condition of the wing. Only the lift-curve results from these two pro-

grams are presented. In the vortex-lattice programs of references 7 and 8, the vortex flow is present to the tip of the wing. At the low angles of attack where the flow is attached, these two programs agree with the experimental data.

The vortex-lattice program of references 7 and 8 accounts for the separated leading-edge vortex flow of the entire wing and shows close agreement with experimental lift data. Also, the potential-flow lift with high-angle-of-attack boundary conditions is presented which causes the lift coefficient to be lower than NARUVLE or the PANAIR pilot code at high angles of attack. The theoretical drag polar from the vortex-lattice program has the experimental $C_{D,o}$ value added to it. The slight difference in experimental and theoretical polars is due to a round leading edge producing some leading-edge suction in the experimental data. At $\alpha > 14°$, the theoretical results of this program do not correctly estimate the nose-up moment, which can be due to the onset of flow separation in the tip area as discussed before.

Figure 18 shows the effect of trailing-edge flap deflections on lift as determined by the NARUVLE program and by experiment. The vortex-lattice program of references 7 and 8 is not used in calculations of figure 18 because flap deflection cannot be modeled easily. At low angles of attack ($\alpha < 4°$), the theoretical results agree with the experimental data up to $\delta_{TE} \approx 15°$. At higher trailing-edge deflections, theory and experiment disagree because of the flow separation at the trailing-edge flap. At $\alpha = 8°$ and $\delta_{TE} = 0°$, the two results, experimental and theoretical, disagree because of the vortex flow caused by the undeflected leading edge which is not modeled in the NARUVLE program.

SUMMARY OF RESULTS

The results of an investigation of the leading- and trailing-edge flaps on an arrow-wing model in the Langley 4- by 7-Meter Tunnel are summarized as follows:

1. Deflecting the leading-edge flap diminishes the vortex lift, which indicates that the leading edge is approaching an attached-flow condition.

2. The drag due to lift is not significantly improved with the leading edge deflected at the desired lift coefficients C_L $(0.5 < C_L < 0.9)$; however, the combined leading- and trailing-edge flap deflections did result in significant improvements in drag due to lift.

3. An increased leading-edge suction can be maintained throughout the lift-coefficient range by scheduling both the leading- and trailing-edge flap deflections when compared with fixed flap deflections.

4. Close approximation of the longitudinal aerodynamic characteristics of the undeflected arrow wing is obtained by using the vortex-lattice method of NASA TN D-6142 and NASA TN D-7921 which accounts for vortex flow, except for the pitching moment at high angles of attack where the wing-tip region is most likely separated.

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TABLE I.- GEOMETRY OF WING

Aspect ratio	1.639
Reference area, ft^2	10.422
Span, ft	4.133
Root chord, ft	4.7458
Tip chord, ft	0.9861
Reference mean aerodynamic chord, ft	3.011
Leading-edge sweep, deg:	
At body station 29.672 in.	70
At body station 86.620 in.	48.7858
Trailing-edge sweep, deg	24.5236
Wing section	NACA 0004

TABLE II.- DEFLECTIONS OF LEADING- AND TRAILING-EDGE FLAPS AND TERMINOLOGY USED

(a) Leading edge

Flap deflections, deg, for segments[a] - Inboard → Outboard							Terminology used
A	B	C	D	E	F	G	
0	0	0	0	0	0	0	$\delta_{LE} = 0°$
10	10	10	10	10	10	10	$\delta_{LE} = 10°$
20	20	20	20	20	20	20	$\delta_{LE} = 20°$
↓	30	30	30	30	30	30	$\delta_{LE} = 30°$
↓	↓	40	40	40	40	40	$\delta_{LE} = 40°$
↓	↓	40	50	50	50	50	$\delta_{LE} = 50°$
↓	↓	40	50	60	60	60	$\delta_{LE} = 60°$

(b) Trailing edge

Flap deflections, deg, for segments[a] - Inboard → Outboard			Terminology used
H	J	K	
0	0	0	$\delta_{TE} = 0°$
10	10	10	$\delta_{TE} = 10°$
20	20	20	$\delta_{TE} = 20°$
30	30	30	$\delta_{TE} = 30°$

[a]Segments are shown in figure 2.

TABLE III.- GEOMETRY OF FUSELAGE

Body station (BS), in.	Cross-sectional area,[a] in^2
0.000	0.000
3.911	1.086
7.822	3.028
11.733	5.430
15.644	8.305
19.555	11.624
23.466	14.852
27.376	16.534
31.287	16.947
35.198	16.198
39.109	15.173
43.020	15.127
46.931	15.387
50.842	15.754
54.753	16.244
58.664	16.871
62.575	17.620
66.486	18.094
70.397	18.232
74.307	18.354
78.218	18.324
82.129	18.079
86.040	17.437
89.951	16.412

[a]The center of each circular area coincides with BL = 0.000.

TABLE IV.- TEST CONFIGURATIONS

Run	Flap deflections, deg, for segments[a] -									
	Leading edge							Trailing edge		
	Inboard ⟶ Outboard							Inboard ⟶ Outboard		
	A	B	C	D	E	F	G	H	J	K
1	0	0	0	0	0	0	0	0	0	0
2								10	10	10
3								20	[illegible]	20
4								30	30	30
20	10	10	10	10	10	10	10	0	0	0
21								10	10	10
5								20	20	20
35								30	30	30
19	20	20	20	20	20	20	20	0	0	0
22								10	10	10
6, 7								20	20	20
34								30	30	30
18	20	30	30	30	30	30	30	0	0	0
23								10	10	10
8								20	20	20
33								30	30	30
17	20	30	40	40	40	40	40	0	0	0
24, 25								10	10	10
9								20	20	20
32								30	30	30
16	20	30	40	50	50	50	50	0	0	0
26, 27, 28								10	10	10
10								20	20	20
31								30	30	30
15	20	30	40	50	60	60	60	0	0	0
29								10	10	10
11								20	20	20
30								30	30	30
[b]14	20	30	40	50	60	60	60	0	0	0
[b]13								10	10	10
[b]12								20	20	20

[a]Segments are shown in figure 2.
[b]Faired leading edge.

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TABLE V.- LONGITUDINAL AERODYNAMIC DATA OF MODIFIED ARROW WING

[Test 234; runs 1 to 35. A summary of the test program is presented in table IV]

TEST = 234
RUN = 1

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
85	.204	60.241	-3.76	-.1265	.0133	-.0005	-9.533
86	.204	60.104	-2.00	-.0617	.0098	-.0016	-6.285
87	.204	60.007	-.03	.0090	.0083	-.0021	1.088
88	.204	59.878	2.02	.0832	.0098	-.0023	8.452
89	.204	59.886	4.10	.1635	.0144	-.0036	11.339
90	.204	60.193	6.10	.2459	.0241	-.0068	10.193
91	.204	60.176	7.99	.3376	.0418	-.0117	8.072
92	.204	60.144	10.03	.4525	.0725	-.0189	6.244
93	.204	60.112	12.12	.5708	.1130	-.0221	5.052
94	.204	60.079	14.07	.6703	.1554	-.0193	4.313
95	.204	59.829	16.17	.7842	.2115	-.0151	3.707
96	.204	59.740	17.79	.8800	.2644	-.0079	3.328
97	.204	60.176	20.19	.9728	.3344	.0071	2.909
98	.205	60.249	21.98	1.0337	.3909	.0230	2.645
99	.204	59.950	24.01	1.1175	.4670	.0371	2.393

TEST = 234
RUN = 2

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
102	.205	60.263	-3.79	.0268	.0126	-.0548	2.128
103	.205	60.263	-2.03	.0941	.0133	-.0557	7.099
104	.205	60.238	.00	.1697	.0167	-.0568	10.172
105	.205	60.214	2.01	.2448	.0230	-.0578	10.652
106	.205	60.214	4.06	.3241	.0328	-.0593	9.872
107	.205	60.069	6.03	.4060	.0484	-.0626	8.395
108	.205	60.012	7.95	.4981	.0719	-.0663	6.929
109	.204	59.972	9.98	.6130	.1090	-.0718	5.624
110	.204	59.867	11.99	.7225	.1533	-.0744	4.714
111	.204	59.689	14.09	.8343	.2077	-.0713	4.017
112	.205	60.052	15.90	.9271	.2607	-.0664	3.556
113	.205	60.085	18.00	1.0289	.3285	-.0585	3.132
114	.205	60.149	20.13	1.1192	.4003	-.0418	2.796
115	.205	60.012	22.02	1.1924	.4693	-.0265	2.541
116	.205	60.028	23.74	1.2399	.5309	-.0043	2.336

TABLE V.- Continued

TEST = 234
RUN = 3

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
120	.205	60.270	-3.55	.1988	.0246	-.1104	8.079
121	.205	60.270	-2.06	.2556	.0286	-.1115	8.948
122	.205	60.092	-.06	.3255	.0355	-.1106	9.177
123	.205	60.076	2.07	.4022	.0470	-.1113	8.553
124	.205	60.076	4.07	.4792	.0622	-.1130	7.700
125	.205	60.020	6.06	.5658	.0843	-.1167	6.710
126	.205	60.197	7.96	.6564	.1130	-.1200	5.810
127	.205	59.955	9.98	.7755	.1578	-.1252	4.914
128	.205	60.189	12.00	.8890	.2097	-.1277	4.239
129	.205	60.181	13.96	.9888	.2659	-.1235	3.719
130	.205	59.955	15.90	1.0823	.3276	-.1168	3.303
132	.205	60.205	17.92	1.1787	.3993	-.1060	2.952
133	.205	60.060	19.98	1.2567	.4721	-.0896	2.662
134	.205	60.044	22.02	1.3292	.5493	-.0687	2.420
136	.205	60.019	23.86	1.3640	.6150	-.0401	2.218

TEST = 234
RUN = 4

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
139	.186	49.961	-3.81	.3106	.0458	-.1500	6.783
140	.187	50.131	-2.03	.3771	.0543	-.1510	6.950
141	.187	50.026	-.03	.4364	.0652	-.1462	6.695
142	.187	50.026	2.03	.5026	.0793	-.1444	6.335
143	.187	50.026	4.05	.5939	.0998	-.1493	5.949
144	.187	50.002	5.96	.6759	.1248	-.1527	5.416
145	.186	49.791	7.99	.7878	.1627	-.1608	4.842
146	.186	49.726	10.03	.9020	.2101	-.1686	4.294
147	.187	50.131	11.97	1.0029	.2639	-.1680	3.800
148	.187	50.034	13.97	1.1043	.3282	-.1640	3.365
149	.187	50.001	15.94	1.1959	.3954	-.1549	3.024
150	.187	50.074	17.98	1.2845	.4691	-.1409	2.738
151	.187	50.050	19.92	1.3572	.5420	-.1250	2.504
152	.186	49.766	21.94	1.4277	.6225	-.1024	2.293
153	.194	53.969	23.98	1.3537	.6455	-.0650	2.097
154	.014	.289	.05	.3835	.0781	-.2434	4.912

TABLE V.- Continued

TEST = 234
RUN = 5

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
157	.205	60.098	-3.85	.1870	.0242	-.1098	7.734
158	.205	59.944	-2.03	.2540	.0292	-.1110	8.712
159	.205	59.944	-.02	.3249	.0355	-.1113	9.156
160	.205	59.880	2.01	.3959	.0448	-.1108	8.834
161	.205	60.171	3.97	.4645	.0569	-.1113	8.170
162	.205	60.066	6.00	.5433	.0745	-.1134	7.290
163	.205	60.025	8.02	.6271	.1000	-.1159	6.269
164	.205	59.985	10.04	.7120	.1330	-.1141	5.354
165	.205	60.114	11.95	.8120	.1759	-.1155	4.616
166	.205	60.049	13.94	.9433	.2399	-.1214	3.932
167	.205	60.049	15.95	1.0369	.3015	-.1132	3.439
168	.205	60.082	17.97	1.1392	.3730	-.1055	3.054
169	.205	59.936	19.94	1.2388	.4507	-.0962	2.749
170	.205	59.758	21.93	1.2808	.5163	-.0707	2.480
171	.205	60.114	23.86	1.3501	.5953	-.0477	2.268

TEST = 234
RUN = 6

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
174	.205	60.041	-3.85	.1778	.0258	-.1089	6.887
175	.205	60.032	-1.98	.2525	.0290	-.1114	8.713
176	.206	60.210	.01	.3243	.0354	-.1122	9.159
177	.205	60.145	1.97	.3938	.0442	-.1128	8.914
178	.205	60.016	3.99	.4620	.0555	-.1122	8.329
179	.205	59.927	5.99	.5344	.0702	-.1139	7.611
180	.206	60.194	7.96	.6146	.0911	-.1174	6.744
181	.206	60.234	9.94	.6909	.1186	-.1170	5.824
182	.205	60.000	11.97	.7693	.1548	-.1119	4.969
183	.205	60.073	13.99	.8481	.1973	-.1055	4.298
184	.205	59.911	16.03	.9484	.2563	-.1027	3.700
185	.205	60.064	18.00	1.0776	.3343	-.1063	3.224

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TABLE V.- Continued

TEST = 234
RUN = 7

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
201	.213	63.666	-3.93	.1669	.0235	-.1020	7.094
202	.206	60.174	-2.11	.2481	.0279	-.1112	8.901
203	.206	60.005	-.01	.3243	.0350	-.1121	9.270
204	.206	60.037	1.95	.3975	.0443	-.1124	8.978
205	.206	60.045	4.05	.4656	.0557	-.1116	8.366
206	.206	59.996	5.98	.5366	.0698	-.1133	7.689
207	.206	59.883	7.91	.6158	.0905	-.1165	6.807
208	.205	59.762	10.03	.6981	.1205	-.1161	5.795
209	.206	59.908	12.03	.7725	.1563	-.1107	4.943
210	.206	60.029	14.02	.8559	.2000	-.1045	4.279
211	.205	59.803	15.95	.9565	.2580	-.1026	3.708
212	.206	59.988	18.00	1.0869	.3388	-.1051	3.208
213	.206	60.037	19.93	1.1884	.4144	-.0966	2.868
214	.206	60.005	22.04	1.2548	.4931	-.0772	2.545
215	.206	60.247	23.74	1.3221	.5663	-.0556	2.335

TEST = 234
RUN = 8

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
218	.206	59.989	-3.91	.1625	.0297	-.1070	5.468
219	.206	60.029	-2.07	.2426	.0301	-.1103	8.053
220	.206	60.158	-.04	.3196	.0356	-.1123	8.988
221	.206	60.029	1.99	.3911	.0444	-.1129	8.801
222	.206	60.086	4.03	.4624	.0559	-.1136	8.278
223	.206	60.053	5.96	.5321	.0694	-.1149	7.671
224	.206	60.029	7.94	.6101	.0888	-.1185	6.867
225	.206	60.118	10.01	.6878	.1155	-.1179	5.954
226	.206	60.069	12.00	.7657	.1479	-.1153	5.177
227	.206	59.956	13.99	.8534	.1935	-.1174	4.411
228	.206	59.900	15.89	.9365	.2430	-.1177	3.854
229	.206	60.255	17.88	1.0608	.3177	-.1224	3.339
230	.206	60.077	19.92	1.1701	.3992	-.1146	2.932
231	.206	59.989	21.92	1.1909	.4566	-.0822	2.608
232	.206	60.053	23.81	1.2880	.5424	-.0739	2.375

TABLE V.- Continued

TEST = 234
RUN = 9

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
235	.206	60.037	-3.91	.1477	.0330	-.1024	4.481
236	.206	60.037	-2.01	.2356	.0331	-.1090	7.123
237	.206	60.053	-.01	.3169	.0372	-.1120	8.521
238	.206	60.078	2.01	.3913	.0450	-.1135	8.697
239	.206	60.053	3.96	.4608	.0557	-.1146	8.279
240	.206	60.191	5.92	.5294	.0693	-.1159	7.639
241	.206	60.182	7.91	.6084	.0897	-.1195	6.781
242	.206	60.142	9.94	.6930	.1176	-.1230	5.894
243	.206	59.908	11.94	.7699	.1488	-.1232	5.173
244	.206	59.956	13.95	.8338	.1814	-.1166	4.598
245	.206	60.037	15.97	.9043	.2219	-.1100	4.075
246	.206	59.916	17.94	.9886	.2760	-.1066	3.581
247	.206	60.142	19.92	1.0967	.3545	-.1051	3.094
248	.206	60.078	21.94	1.1634	.4242	-.0905	2.743
249	.206	60.102	23.95	1.2248	.5011	-.0739	2.444

TEST = 234
RUN = 10

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
252	.206	60.183	-3.92	.1369	.0369	-.1005	3.707
253	.213	63.884	-2.06	.2132	.0339	-.1005	6.292
254	.206	60.086	-.04	.3092	.0393	-.1110	7.858
255	.206	60.094	1.97	.3866	.0467	-.1139	8.278
256	.206	60.037	3.94	.4566	.0567	-.1155	8.059
257	.213	63.852	5.92	.4976	.0663	-.1106	7.500
258	.206	60.134	7.91	.6040	.0908	-.1205	6.655
259	.206	60.134	9.94	.6835	.1190	-.1221	5.746
260	.206	60.021	11.93	.7740	.1541	-.1262	5.024
261	.206	59.989	13.92	.8470	.1881	-.1231	4.504
262	.206	59.908	15.96	.9196	.2288	-.1186	4.019
263	.206	59.981	17.88	.9891	.2755	-.1139	3.590
264	.206	60.118	19.93	1.0581	.3313	-.1050	3.194
265	.206	60.175	21.95	1.1473	.4033	-.1025	2.844
266	.206	59.949	23.93	1.2329	.4849	-.0920	2.543

TABLE V.- Continued

TEST = 234
RUN = 11

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
269	.206	60.006	-3.92	.1289	.0395	-.0966	3.266
270	.206	59.989	-2.02	.2216	.0384	-.1051	5.770
271	.206	60.006	-.09	.3014	.0419	-.1096	7.198
272	.206	59.965	1.92	.3785	.0492	-.1116	7.686
273	.206	59.949	3.94	.4554	.0614	-.1135	7.418
274	.206	60.022	5.94	.5286	.0745	-.1183	7.094
275	.206	59.973	7.96	.6102	.0961	-.1221	6.350
276	.206	60.046	10.03	.6954	.1271	-.1247	5.472
277	.206	60.006	11.91	.7773	.1604	-.1268	4.845
278	.206	60.014	13.94	.8535	.1967	-.1255	4.340
279	.206	59.990	15.95	.9221	.2362	-.1209	3.903
280	.206	60.054	17.91	1.0047	.2876	-.1222	3.493
281	.206	59.990	17.87	1.0699	.3398	-.1113	3.148
282	.205	59.917	21.92	1.1411	.4007	-.1012	2.847
283	.205	59.933	23.85	1.2104	.4687	-.0845	2.582

TEST = 234
RUN = 12

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
286	.206	60.079	-3.93	.1300	.0386	-.0983	3.369
287	.206	59.998	-2.02	.2218	.0376	-.1058	5.894
288	.206	60.014	-.05	.3040	.0407	-.1101	7.464
289	.206	60.062	1.95	.3807	.0473	-.1127	8.056
290	.206	60.119	3.97	.4578	.0574	-.1154	7.980
291	.206	60.087	5.99	.5324	.0717	-.1182	7.429
292	.206	59.990	7.99	.6126	.0941	-.1223	6.512
293	.206	60.143	9.94	.6938	.1239	-.1240	5.601
294	.206	60.200	11.93	.7789	.1581	-.1272	4.927
295	.206	60.111	13.94	.8524	.1935	-.1259	4.405
296	.205	59.957	15.88	.9242	.2327	-.1244	3.971
297	.206	60.054	17.86	1.0036	.2810	-.1214	3.571
298	.206	60.006	19.96	1.0782	.3387	-.1151	3.184
299	.206	59.973	21.90	1.1582	.4069	-.1021	2.846
300	.205	59.820	23.93	1.1795	.4630	-.0643	2.547

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TABLE V.- Continued

TEST = 234
RUN = 13

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
303	.206	60.022	-3.93	-.0419	.0341	-.0413	-1.229
304	.206	60.208	-2.07	.0530	.0280	-.0495	1.895
305	.205	59.947	-.09	.1434	.0259	-.0564	5.527
306	.206	60.014	1.91	.2267	.0277	-.0601	8.176
307	.206	60.055	3.94	.3068	.0327	-.0628	9.395
308	.206	60.047	5.96	.3813	.0421	-.0658	9.055
309	.206	60.038	7.95	.4638	.0586	-.0696	7.919
310	.206	60.265	9.94	.5465	.0828	-.0724	6.603
311	.206	60.006	11.94	.6288	.1108	-.0750	5.675
312	.205	59.893	13.91	.7102	.1431	-.0776	4.965
313	.205	59.885	15.91	.7896	.1796	-.0771	4.396
314	.205	59.748	17.90	.8753	.2259	-.0771	3.874
315	.205	59.716	19.97	.9496	.2763	-.0703	3.436
316	.205	59.869	21.91	1.0286	.3362	-.0565	3.060
317	.205	59.909	23.89	1.0806	.3979	-.0281	2.716

TEST = 234
RUN = 14

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
320	.206	60.095	-3.89	-.2072	.0413	.0152	-5.018
321	.206	60.168	-2.05	-.1125	.0301	.0080	-3.737
322	.205	59.934	-.09	-.0230	.0230	.0014	-1.000
323	.205	59.990	1.94	.0625	.0193	-.0035	3.232
324	.205	59.974	3.94	.1466	.0195	-.0071	7.506
325	.206	60.233	5.99	.2245	.0236	-.0104	9.515
326	.206	60.184	8.00	.3060	.0340	-.0146	9.007
327	.205	59.974	10.05	.4004	.0546	-.0202	7.329
328	.206	60.095	12.02	.4834	.0775	-.0227	6.237
329	.206	60.104	14.00	.5666	.1051	-.0253	5.393
330	.206	60.168	15.95	.6503	.1376	-.0270	4.725
331	.206	60.112	17.90	.7368	.1775	-.0273	4.151
332	.205	59.845	19.97	.8183	.2234	-.0233	3.663
333	.206	60.209	21.92	.8921	.2745	-.0106	3.250
334	.205	59.966	23.86	.9688	.3390	.0115	2.858

TABLE V.- Continued

TEST = 234
RUN = 15

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
353	.205	59.978	-3.85	-.2020	.0411	.0146	-4.920
354	.205	59.994	-2.11	-.1140	.0302	.0080	-3.775
355	.205	60.100	-.04	-.0217	.0224	.0016	-.970
356	.205	60.011	2.01	.0659	.0197	-.0034	3.351
357	.205	60.003	4.08	.1507	.0219	-.0058	6.898
358	.205	59.922	6.10	.2313	.0270	-.0093	8.575
359	.205	59.930	7.96	.3079	.0371	-.0133	8.300
360	.205	60.043	9.99	.3993	.0571	-.0192	6.992
361	.205	60.043	11.97	.4934	.0834	-.0249	5.913
362	.205	60.019	13.94	.5783	.1128	-.0262	5.127
363	.205	60.019	16.09	.6668	.1501	-.0257	4.442
364	.205	60.067	17.98	.7392	.1861	-.0210	3.971
365	.205	60.027	19.94	.8252	.2340	-.0190	3.526
366	.205	60.035	20.01	.8298	.2368	-.0189	3.504
367	.205	60.068	21.92	.9035	.2860	-.0057	3.159
368	.205	59.898	23.99	.9765	.3489	.0181	2.799

TEST = 234
RUN = 16

PT	MACH	Q	ALPHA	CL		CM	L/D
371	.205	60.165	-3.84	-.2015	[illegible]	.0129	-5.356
372	.205	60.060	-2.00	-.1103	.0268	.0063	-4.111
373	.205	60.028	-.01	-.0150	.0199	-.0009	-.757
374	.205	59.995	1.99	.0696	.0169	-.0051	4.108
375	.204	59.923	3.97	.1485	.0174	-.0079	8.533
376	.204	59.907	6.00	.2251	.0221	-.0102	10.185
377	.205	59.987	8.01	.3070	.0328	-.0134	9.350
378	.204	59.874	10.06	.3945	.0517	-.0180	7.629
379	.205	59.963	12.03	.4878	.0772	-.0237	6.318
380	.205	60.092	14.03	.5748	.1059	-.0263	5.430
381	.205	59.987	16.14	.6613	.1412	-.0270	4.684
382	.205	59.947	17.91	.7315	.1748	-.0248	4.184
383	.204	59.939	19.98	.8045	.2187	-.0161	3.678
384	.204	59.907	22.02	.8913	.2767	-.0061	3.221
385	.204	59.874	24.05	.9760	.3439	.0090	2.838

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TABLE V.- Continued

TEST = 234
RUN = 17

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
388	.205	60.125	-3.82	-.1937	.0341	.0106	-5.677
389	.205	60.076	-1.99	-.0973	.0236	.0035	-4.124
390	.205	60.044	.00	-.0065	.0173	-.0022	-.376
391	.205	60.020	1.95	.0738	.0149	-.0050	4.968
392	.205	59.947	3.91	.1500	.0159	-.0070	9.463
393	.204	59.858	5.98	.2266	.0202	-.0096	11.241
394	.205	60.092	7.93	.3020	.0297	-.0115	10.158
395	.205	60.084	9.94	.3878	.0477	-.0152	8.134
396	.205	60.084	12.00	.4800	.0723	-.0206	6.643
397	.205	60.044	13.96	.5672	.0996	-.0228	5.695
398	.205	60.060	15.87	.6364	.1283	-.0193	4.959
399	.205	60.068	17.91	.7163	.1682	-.0155	4.260
400	.205	60.092	20.06	.8141	.2257	-.0107	3.607
401	.204	59.834	21.92	.9067	.2928	.0053	3.097
402	.205	59.955	23.96	.9931	.3649	.0159	2.722

TEST = 234
RUN = 18

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
406	.205	60.011	-3.77	-.1733	.0288	.0051	-6.012
407	.205	59.946	-2.06	-.0876	.0198	-.0001	-4.414
408	.205	59.938	-.01	.0012	.0145	-.0034	.082
409	.205	59.938	2.10	.0838	.0133	-.0059	6.288
410	.204	59.857	4.03	.1591	.0157	-.0074	10.132
411	.204	59.833	6.04	.2348	.0217	-.0099	10.807
412	.205	60.043	6.03	.2344	.0217	-.0099	10.778
413	.212	63.883	8.00	.2915	.0297	-.0115	9.803
414	.205	59.946	10.11	.4000	.0499	-.0169	8.008
415	.205	60.116	12.09	.4815	.0720	-.0192	6.683
416	.205	60.035	14.04	.5640	.1003	-.0173	5.622
417	.205	60.003	15.91	.6459	.1358	-.0162	4.758
418	.204	59.841	17.97	.7517	.1887	-.0143	3.983
419	.205	60.092	19.99	.8483	.2482	-.0074	3.417
420	.205	60.019	21.92	.9207	.3076	.0104	2.993
421	.205	60.140	23.99	1.0112	.3808	.0224	2.655

TABLE V.- Continued

TEST = 234
RUN = 19

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
425	.205	60.109	-3.82	-.1516	.0224	.0016	-6.767
426	.205	60.173	-1.97	-.0693	.0141	-.0015	-4.903
427	.205	60.076	-.04	.0076	.0108	-.0039	.703
428	.205	60.028	1.97	.0824	.0109	-.0049	7.571
429	.205	60.020	4.00	.1582	.0139	-.0057	11.374
430	.204	59.907	5.97	.2310	.0195	-.0074	11.851
431	.205	59.971	8.03	.3095	.0297	-.0097	10.416
432	.204	59.899	10.05	.3927	.0468	-.0112	8.383
433	.205	60.028	12.07	.4777	.0728	-.0106	6.565
434	.204	59.931	14.00	.5645	.1053	-.0091	5.360
435	.205	60.222	15.98	.6728	.1523	-.0112	4.419
436	.205	60.262	17.99	.7858	.2116	-.0095	3.713
437	.205	60.101	20.04	.8819	.2755	.0001	3.202
438	.205	59.979	21.96	.9522	.3338	.0165	2.852
439	.205	60.060	23.98	1.0409	.4083	.0332	2.549

TEST = 234
RUN = 20

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
442	.205	60.028	-3.79	-.1351	.0165	-.0004	-8.165
443	.205	60.125	-2.01	-.0619	.0117	-.0026	-5.299
444	.205	60.020	.01	.0142	.0100	-.0033	1.423
445	.204	59.996	2.04	.0879	.0109	-.0035	8.059
446	.204	59.980	4.02	.1615	.0141	-.0042	11.433
447	.205	60.053	6.01	.2361	.0207	-.0062	11.432
448	.205	60.109	7.96	.3152	.0328	-.0088	9.597
449	.205	60.109	9.98	.4018	.0542	-.0101	7.412
450	.205	60.020	12.01	.5029	.0866	-.0104	5.804
451	.204	60.004	14.00	.6199	.1314	-.0142	4.718
452	.205	60.029	16.01	.7281	.1830	-.0124	3.978
453	.212	63.941	17.96	.7726	.2235	-.0048	3.457
454	.204	59.940	20.00	.9142	.2998	.0057	3.050
455	.204	59.972	22.02	.9866	.3616	.0236	2.729
456	.204	59.996	23.98	1.0945	.4442	.0307	2.464

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TABLE V.- Continued

TEST = 234
RUN = 21

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
459	.204	60.005	-3.81	.0287	.0138	-.0555	2.085
460	.204	59.972	-2.05	.0966	.0138	-.0568	7.023
461	.205	60.085	-.01	.1720	.0170	-.0579	10.115
462	.204	59.883	2.02	.2476	.0225	-.0592	10.997
463	.205	60.093	4.03	.3224	.0303	-.0601	10.627
464	.205	60.118	5.98	.3949	.0420	-.0620	9.396
465	.204	60.037	7.96	.4767	.0608	-.0636	7.843
466	.205	60.126	10.01	.5635	.0893	-.0637	6.309
467	.205	60.053	12.03	.6613	.1275	-.0621	5.186
468	.204	59.924	14.03	.7811	.1802	-.0671	4.334
469	.205	60.069	16.04	.8849	.2377	-.0623	3.723
470	.211	63.868	17.97	.9129	.2788	-.0512	3.274
471	.204	59.746	19.97	1.0654	.3657	-.0437	2.913
472	.204	59.980	21.97	1.1512	.4396	-.0288	2.619
473	.205	60.085	23.94	1.2189	.5131	-.0113	2.376

TEST = 234
RUN = 22

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
490	.204	60.070	-3.89	.0139	.0185	-.0543	.751
491	.204	60.045	-2.07	.0923	.0156	-.0567	5.931
492	.204	59.948	-.09	.1688	.0172	-.0589	9.840
493	.204	60.062	1.99	.2483	.0222	-.0607	11.161
494	.205	60.102	3.97	.3189	.0293	-.0620	10.877
495	.204	60.045	5.98	.3933	.0396	-.0631	9.921
496	.204	60.013	7.98	.4706	.0553	-.0647	8.505
497	.205	60.118	9.97	.5487	.0782	-.0648	7.018
498	.204	60.013	11.93	.6246	.1084	-.0612	5.763
499	.204	59.892	13.96	.7091	.1475	-.0571	4.807
500	.204	59.714	15.94	.8224	.2013	-.0585	4.085
501	.204	59.908	17.97	.9329	.2654	-.0578	3.515
502	.204	60.079	19.94	1.0218	.3328	-.0463	3.071
503	.204	59.860	21.94	1.0843	.3972	-.0254	2.730
504	.204	59.937	23.96	1.1647	.4736	-.0114	2.454

TABLE V.- Continued

TEST = 234
RUN = 23

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
507	.204	59.949	-3.93	-.0048	.0238	-.0522	-.203
508	.205	60.150	-2.06	.0834	.0187	-.0561	4.451
509	.204	60.005	-.02	.1660	.0184	-.0589	9.003
510	.204	59.973	2.01	.2433	.0224	-.0614	10.866
511	.204	59.981	3.97	.3183	.0296	-.0630	10.736
512	.204	60.029	5.96	.3869	.0389	-.0645	9.946
513	.204	59.989	7.96	.4669	.0545	-.0671	8.574
514	.204	59.997	9.97	.5455	.0759	-.0684	7.188
515	.204	60.029	11.98	.6244	.1024	-.0673	6.099
516	.204	60.021	14.00	.6942	.1342	-.0627	5.173
517	.204	60.045	16.01	.7881	.1813	-.0605	4.348
518	.204	60.021	18.04	.8873	.2423	-.0531	3.662
519	.204	60.005	19.96	.9711	.3050	-.0367	3.184
520	.204	59.835	21.97	1.0773	.3835	-.0316	2.809
521	.205	60.134	23.94	1.1654	.4616	-.0188	2.525

TEST = 234
RUN = 24

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
524	.204	60.029	-3.91	-.0300	.0288	-.0470	-1.043
525	.204	60.053	-2.11	.0686	.0232	-.0554	2.956
526	.204	60.070	-.04	.1591	.0217	-.0597	7.334
527	.205	60.126	1.97	.2368	.0243	-.0617	9.729
528	.204	60.062	3.97	.3143	.0300	-.0639	10.476
529	.205	60.086	5.94	.3860	.0394	-.0656	9.805
530	.204	60.070	7.93	.4601	.0539	-.0673	8.531
531	.205	60.247	9.94	.5510	[illegible]	-.0730	6.973
532	.205	60.118	11.97	.6376	.107	-.0759	5.951
533	.205	60.183	13.95	.7059	.136	-.0730	5.189
534	.204	59.924	15.96	.7763	[illegible]	-.0666	4.543

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TABLE V.- Continued

TEST = 234
RUN = 25

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
518	.204	59.972	-3.92	-.0243	.0277	-.0466	-.878
519	.204	59.803	-2.15	.0671	.0223	-.0546	3.008
520	.205	60.134	-.03	.1599	.0209	-.0587	7.666
521	.205	60.077	2.02	.2401	.0234	-.0611	10.255
522	.204	59.948	4.02	.3166	.0296	-.0635	10.697
5[illegible]	.205	60.223	6.02	.3886	.0393	-.0651	9.877
524	.205	60.247	7.93	.4598	.0534	-.0665	8.605
525	.205	60.247	10.10	.5581	.0808	-.0725	6.905
526	.205	60.214	11.95	.6339	.1062	-.0744	5.969
527	.205	60.150	14.00	.7077	.1360	-.0721	5.203
528	.204	59.972	15.91	.7738	.1693	-.0667	4.570
529	.205	60.166	17.88	.8673	.2258	-.0553	3.842
530	.204	60.013	19.86	.9619	.2895	-.0404	3.323
531	.204	60.037	22.05	1.0491	.3640	-.0270	2.882
532	.204	59.997	23.90	1.1198	.4325	-.0133	2.589

TEST = 234
RUN = 26

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
535	.205	60.118	-3.87	-.0352	.0313	-.0432	-1.124
536	.205	60.069	-2.11	.0574	.0253	-.0513	2.267
537	.204	59.932	-.05	.1505	.0237	-.0575	6.352
538	.204	59.916	1.99	.2346	.0[illegible]72	-.0606	8.635
539	.204	59.981	3.94	.3090	.0335	-.0624	9.233
540	.204	59.916	5.94	.3848	.04[illegible]6	-.0647	8.627
541	.204	59.876	7.98	.4641	0634	-.0650	7.322
542	.204	60.021	9.91	.5426	.0867	-.0681	6.259
543	.204	60.013	11.97	.6345	.1180	-.0712	5.375
544	.204	59.932	13.98	.7320	.1544	-.0815	4.741
545	.205	60.093	15.95	.8128	.1914	-.0824	4.247
546	.205	60.053	18.01	.8958	.2391	-.0733	3.747
547	.205	60.037	19.83	.9589	.2897	-.0564	3.310
548	.204	59.988	21.93	1.0818	.3696	-.0532	2.927
549	.204	59.964	23.74	1.1050	.4177	-.0113	2.645

TABLE V.- Continued

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TEST = 234
RUN = 27

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
552	.204	59.924	-3.90	-.0371	.0304	-.0433	-1.222
553	.205	60.061	-1.98	.0636	.0241	-.0521	2.637
554	.204	59.996	.01	.1525	.0230	-.0580	6.635
555	.204	59.948	2.02	.2356	.0256	-.0616	9.212
556	.204	59.907	3.88	.3067	.0312	-.0640	9.830
557	.205	60.028	5.91	.3833	.0407	-.0674	9.425
558	.204	59.964	7.90	.4642	.0589	-.0699	7.884
559	.205	60.036	10.04	.5523	.0858	-.0718	6.439
560	.205	59.996	11.90	.6371	.1138	-.0750	5.597
561	.204	59.955	13.89	.7110	.1442	-.0731	4.931
562	.205	59.980	15.98	.7891	.1805	-.0711	4.372
563	.204	59.915	17.88	.8725	.2263	-.0691	3.855
564	.205	60.084	19.90	.9442	.2859	-.0480	3.303
565	.205	59.971	21.89	1.0634	.3630	-.0405	2.929
566	.205	60.036	23.85	1.1335	.4301	-.0195	2.636

TEST = 234
RUN = 28

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
570	.205	60.059	-3.60	-.0166	.0289	-.0455	-.574
571	.205	59.953	-2.15	.0578	.0245	-.0514	2.363
572	.205	60.034	-.06	.1520	.0229	-.0579	6.649
573	.205	59.986	1.93	.2318	.0256	-.0615	9.065
574	.205	60.115	3.92	.3095	.0315	-.0641	9.823
575	.205	60.075	5.88	.3856	.0409	-.0672	9.438
576	.205	60.091	7.84	.4573	.0558	-.0692	8.192
577	.205	60.058	9.92	.5421	.0786	-.0716	6.897
578	.205	60.026	11.90	.6269	.1066	-.0773	5.883
579	.205	59.945	13.99	.7171	.1410	-.0776	5.088
580	.205	59.971	15.93	.7899	.1765	-.0751	4.474
581	.205	60.066	17.83	.8669	.2197	-.0721	3.946
582	.205	59.970	19.99	.9531	.2792	-.0654	3.413
583	.205	59.961	21.95	1.0304	.3437	-.0423	2.998
584	.205	60.091	23.71	1.0994	.4130	-.0201	2.662

TABLE V.- Continued

TEST = 234
RUN = 29

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
587	.205	59.978	-3.90	-.0374	.0336	-.0417	-1.113
588	.205	60.059	-2.09	.0562	.0277	-.0500	2.026
589	.205	60.002	-.01	.1487	.0258	-.0567	5.773
590	.205	60.091	1.98	.2293	.0280	-.0609	8.178
591	.205	60.059	4.00	.3086	.0338	-.0639	9.120
592	.205	60.010	5.95	.3849	.0436	-.0672	8.833
593	.205	60.018	7.92	.4628	.0588	-.0702	7.870
594	.205	60.043	9.97	.5422	.0812	-.0722	6.677
595	.205	59.970	11.94	.6255	.1104	-.0738	5.668
596	.205	60.010	13.96	.7126	.1442	-.0772	4.940
597	.205	59.938	15.94	.7897	.1806	-.0745	4.372
598	.205	60.019	17.93	.8675	.2236	-.0723	3.880
599	.205	59.954	19.93	.9512	.2787	-.0704	3.413
600	.205	59.898	21.93	1.0201	.3375	-.0452	3.022
601	.205	59.971	23.80	1.0850	.4026	-.0126	2.695

TEST = 234
RUN = 30

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
604	.205	60.027	-3.94	.2449	.0587	-.1338	4.175
605	.204	59.858	-2.08	.3276	.0619	-.1398	5.296
606	.205	59.963	-.03	.4035	.0688	-.1417	5.868
607	.205	60.011	2.00	.4757	.0792	-.1435	6.008
608	.205	60.019	3.98	.5511	.0925	-.1461	5.959
609	.205	59.963	5.95	.6200	.1085	-.1483	5.716
610	.205	59.995	7.91	.7015	.1327	-.1537	5.288
611	.205	59.963	9.94	.7880	.1625	-.1590	4.851
612	.205	60.003	11.93	.8624	.1973	-.1581	4.371
613	.204	59.898	13.94	.9436	.2394	-.1584	3.942
614	.205	59.939	15.95	1.0084	.2795	-.1509	3.608
615	.204	59.882	17.96	1.0829	.3328	-.1483	3.254
616	.205	60.060	19.94	1.1471	.3911	-.1365	2.933
617	.204	59.721	21.95	1.2239	.4614	-.1128	2.653
618	.205	59.995	23.82	1.2700	.5280	-.0777	2.405

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TABLE V.- Continued

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TEST = 234
RUN = 31

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
621	.205	60.108	-3.96	.2463	.0572	-.1352	4.308
622	.205	60.149	-2.04	.3301	.0602	-.1402	5.488
623	.205	60.221	-.06	.4087	.0676	-.1435	6.049
624	.205	60.230	2.00	.4799	.0779	-.1442	6.160
625	.205	60.213	3.93	.5426	.0894	-.1442	6.068
626	.205	60.213	5.94	.6174	.1061	-.1471	5.818
627	.205	60.189	7.91	.7026	.1302	-.1543	5.397
628	.205	60.229	9.91	.7925	.1605	-.1632	4.937
629	.205	60.141	11.92	.8687	.1950	-.1611	4.454
630	.205	60.084	13.93	.9418	.2348	-.1587	4.011
631	.205	59.979	15.93	1.0051	.2757	-.1522	3.646
632	.204	59.906	17.90	1.0799	.3279	-.1472	3.294
633	.205	59.955	19.97	1.1434	.3855	-.1373	2.966
634	.205	59.979	21.98	1.2396	.4681	-.1343	2.648
635	.205	60.003	23.82	1.3448	.5638	-.1182	2.385

TEST = 234
RUN = 32

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
638	.205	60.068	-3.95	.2463	.0543	-.1346	4.538
639	.205	59.987	-2.04	.3326	.0582	-.1404	5.717
640	.205	60.092	.01	.4103	.0669	-.1430	6.131
641	.205	60.068	1.98	.4774	.0775	-.1424	6.162
642	.205	60.028	3.98	.5443	.0916	-.1424	5.945
643	.205	60.020	5.91	.6098	.1045	-.1433	5.836
644	.205	59.971	7.92	.6982	.1280	-.1501	5.457
645	.205	60.173	9.92	.7860	.1579	-.1571	4.979
646	.205	60.125	11.94	.8596	.1905	-.1542	4.512
647	.205	60.052	13.96	.9369	.2327	-.1524	4.027
648	.205	60.036	16.01	1.0096	.2793	-.1473	3.614
649	.204	59.915	17.91	1.1009	.3452	-.1432	3.189
651	.205	60.141	19.95	1.1842	.4192	-.1311	2.825
652	.204	59.931	21.94	1.2791	.5019	-.1177	2.548
653	.205	60.004	23.94	1.3361	.5841	-.0876	2.287

TABLE V.- Continued

TEST = 234
RUN = 33

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
663	.205	60.076	-3.96	.2869	.0482	-.1471	5.957
664	.205	59.979	-2.17	.3609	.0537	-.1496	6.721
665	.204	59.947	-.07	.4335	.0637	-.1497	6.810
668	.205	60.020	3.89	.5576	.0875	-.1453	6.376
669	.205	59.988	5.91	.6269	.1031	-.1461	6.078
670	.205	59.988	7.90	.7099	.1259	-.1512	5.638
671	.205	59.955	9.90	.7935	.1555	-.1543	5.102
672	.204	59.931	11.91	.8720	.1916	-.1532	4.552
673	.205	60.004	13.91	.9551	.2393	-.1521	3.991
674	.205	60.020	15.85	1.0356	.2932	-.1487	3.532
675	.204	59.729	17.94	1.1633	.3781	-.1491	3.077
676	.204	59.947	19.86	1.2341	.4480	-.1362	2.755
677	.205	59.987	21.85	1.2965	.5218	-.1121	2.485
678	.204	59.810	23.90	1.3791	.6126	-.0984	2.251

TEST = 234
RUN = 34

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
683	.205	60.124	-4.01	.3001	.0456	-.1490	6.575
684	.205	59.939	-2.13	.3667	.0535	-.1498	6.855
685	.205	60.027	-.07	.4356	.0641	-.1486	6.800
686	.205	60.011	1.93	.4957	.0753	-.1459	6.581
687	.205	59.914	3.92	.5603	.0881	-.1434	6.357
688	.204	59.890	5.88	.6312	.1047	-.1446	6.030
689	.205	59.914	7.88	.7211	.1298	-.1523	5.557
690	.204	59.890	9.91	.8102	.1637	-.1567	4.949
691	.205	59.9[illegible]9	11.91	.8892	.2033	-.1522	4.375
692	.204	59.825	13.94	.9891	.2599	-.1517	3.006
693	.205	60.060	15.89	1.1106	.3332	-.1566	3.333
694	.205	59.963	17.90	1.1622	.3977	-.1340	2.922
695	.204	59.858	19.91	1.2455	.4708	-.1228	2.645
696	.205	60.011	21.85	1.3340	.5519	-.1110	2.417
697	.205	60.019	23.83	1.4041	.6343	-.0899	2.214

TABLE V.- Concluded

TEST = 234
RUN = 35

PT	MACH	Q	ALPHA	CL	CD	CM	L/D
719	.204	59.942	-3.90	.3013	.0451	-.1473	6.683
720	.204	59.894	-2.04	.3697	.0540	-.1484	6.845
721	.204	59.926	.02	.4382	.0649	-.1472	6.754
722	.204	60.015	1.95	.4983	.0763	-.1448	6.535
723	.204	59.870	3.97	.5718	.0914	-.1446	6.258
724	.204	59.918	5.99	.6496	.1127	-.1478	5.763
725	.204	60.136	7.96	.7508	.1431	-.1578	5.247
726	.204	60.201	10.00	.8462	.1839	-.1596	4.600
727	.204	60.015	11.93	.9533	.2355	-.1636	4.047
728	.204	59.725	13.99	1.0679	.3007	-.1646	3.551
729	.203	59.474	16.01	1.1801	.3735	-.1630	3.160
730	.203	59.506	17.98	1.2695	.4476	-.1519	2.836
731	.204	59.757	20.07	1.3463	.5248	-.1320	2.566
732	.211	63.638	21.93	1.2932	.5506	-.0966	2.349
733	.204	60.032	24.01	1.4206	.6617	-.0795	2.147

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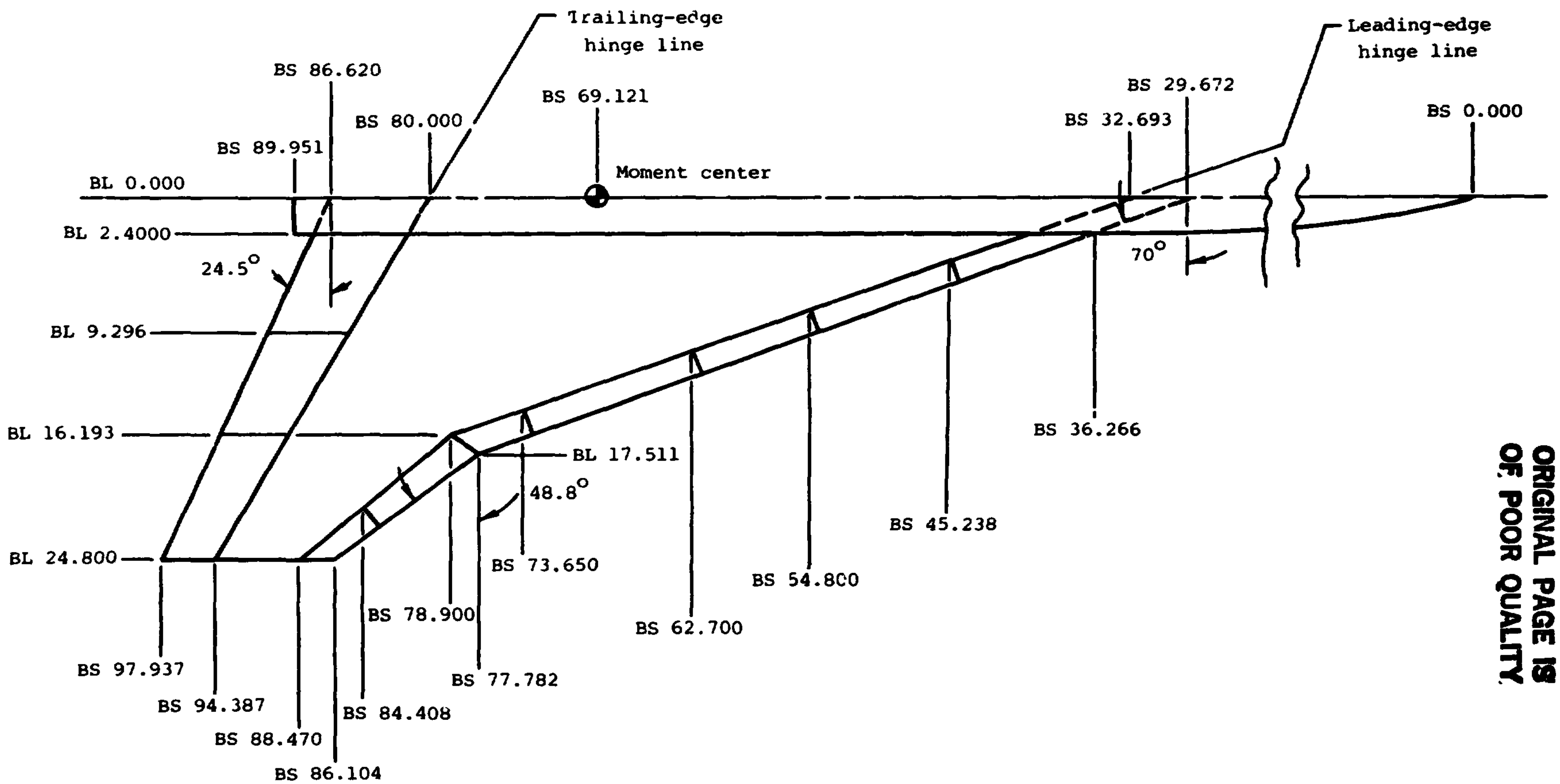

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Figure 1.- Model geometry. Dimensions are in inches.

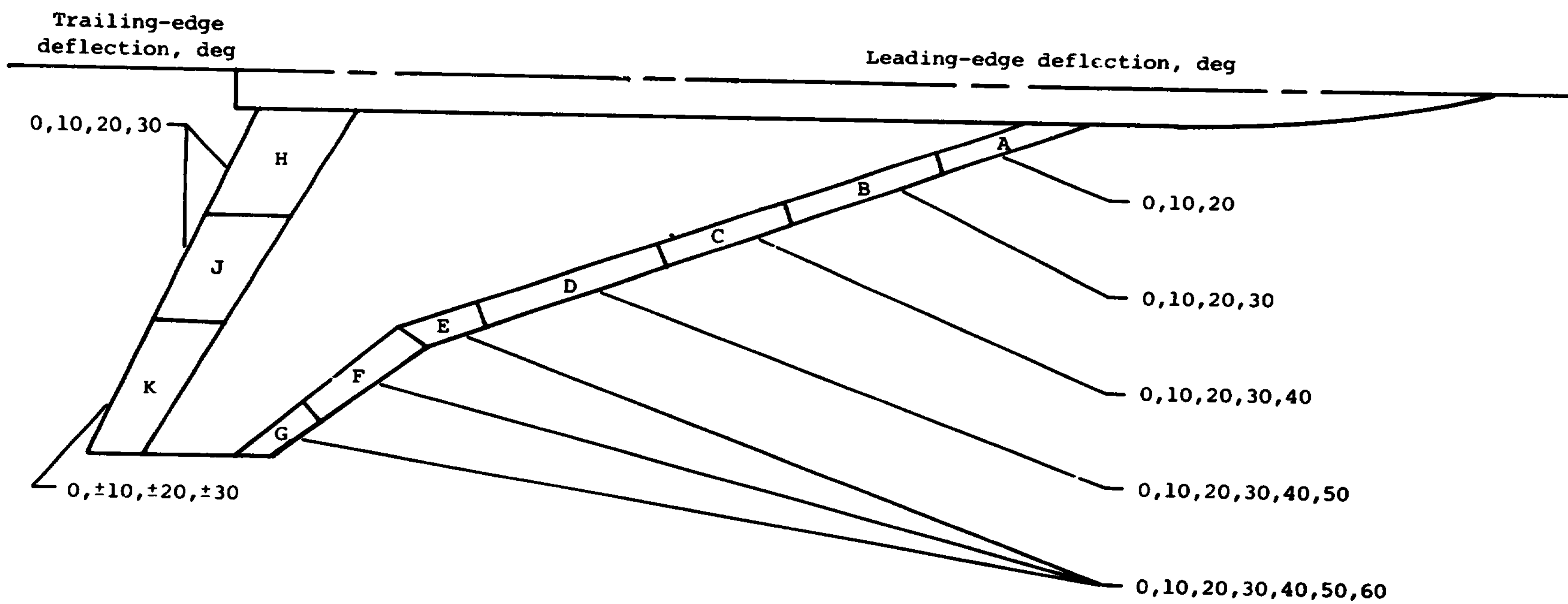

Figure 2.- Leading- and trailing-edge deflections and terminology for indicated segments.

L-80-10,905

Figure 3.- Model of modified arrow wing in the Langley 4- by 7-Meter Tunnel.

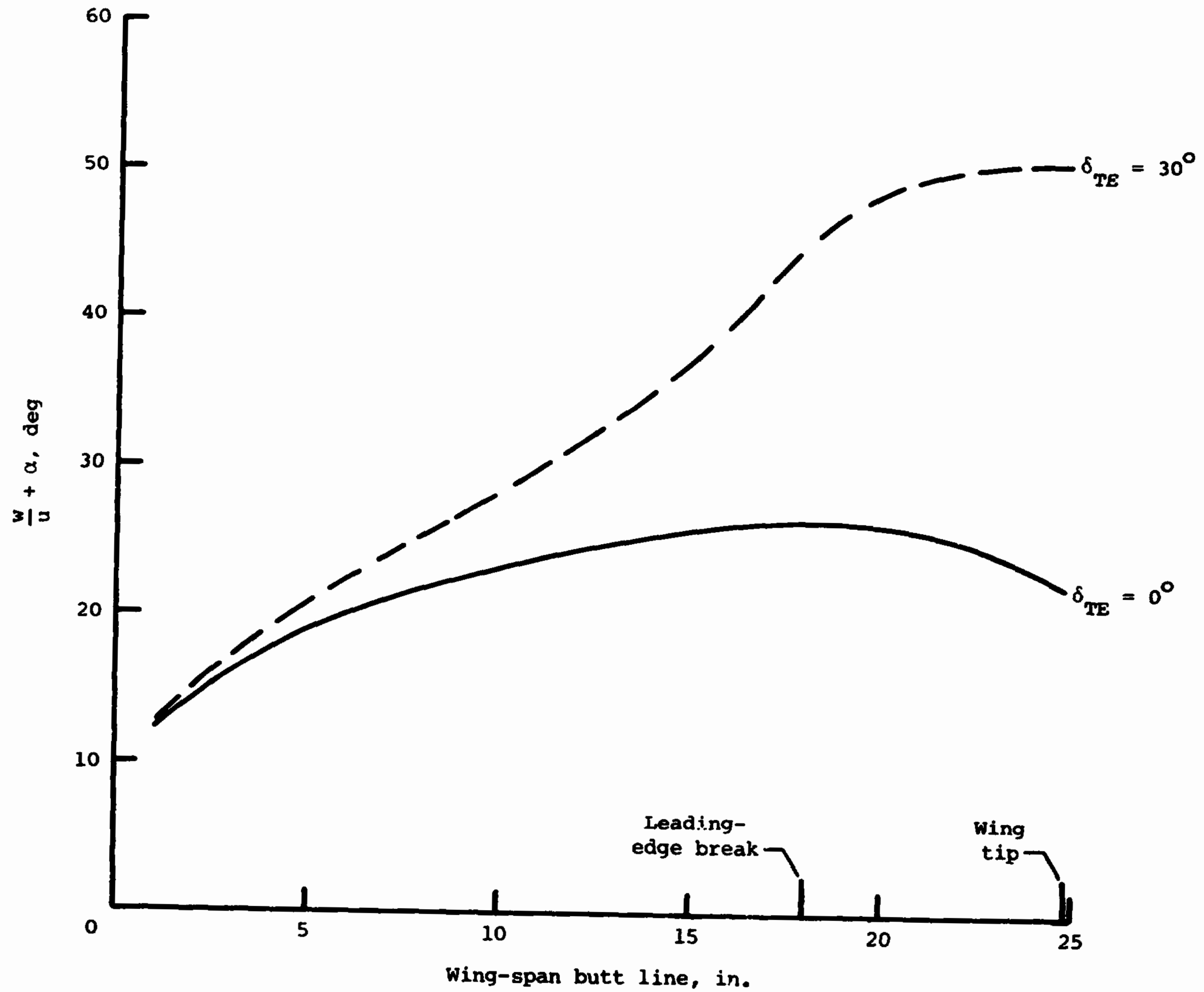

Figure 4.- Effect of two trailing-edge deflections (0° and 30°) on upwash angle along span of wing. $\alpha = 10°$.

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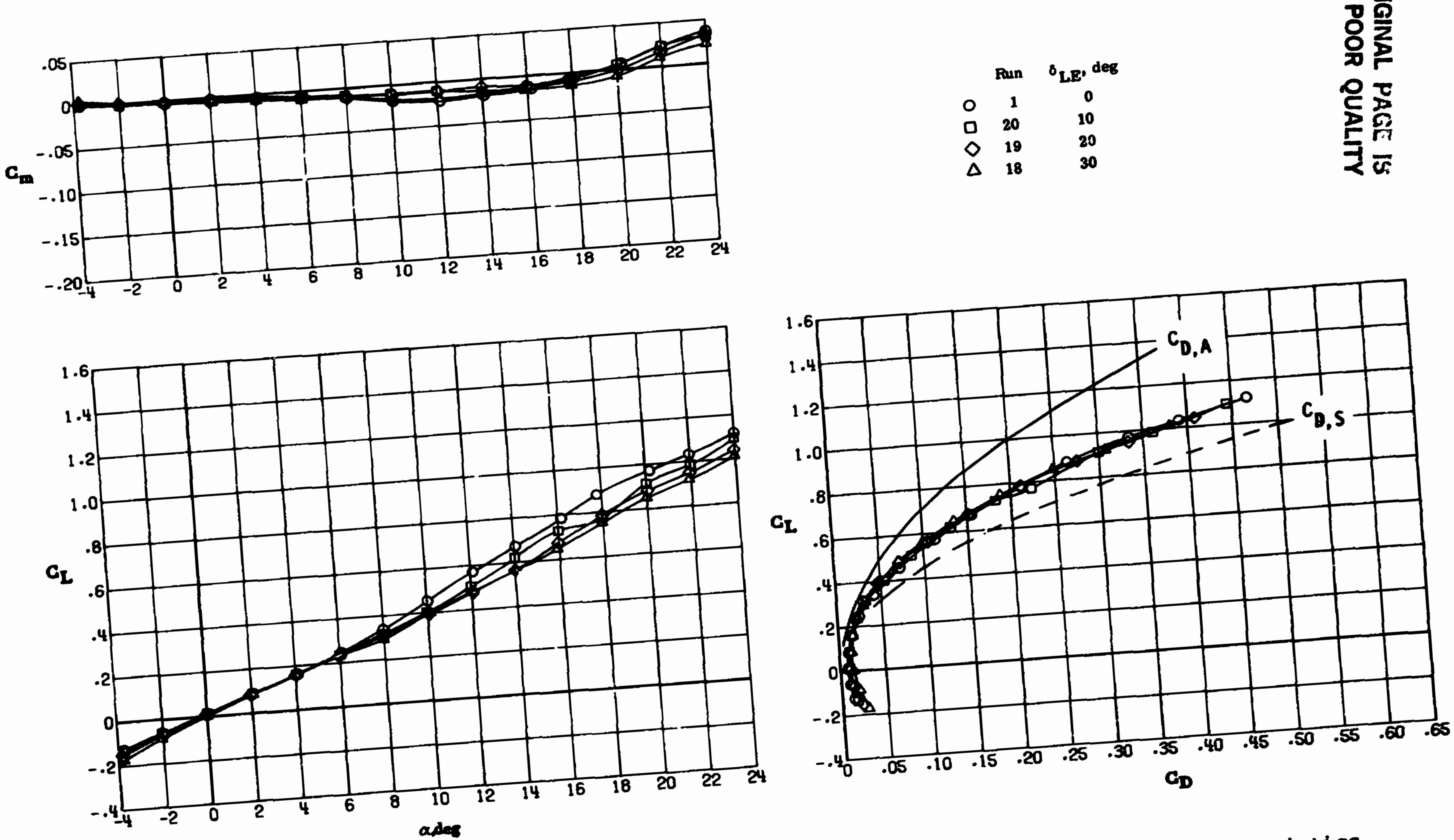

Figure 5.- Effect of leading-edge flap deflections on longitudinal aerodynamic characteristics with $\delta_{TE} = 0°$.

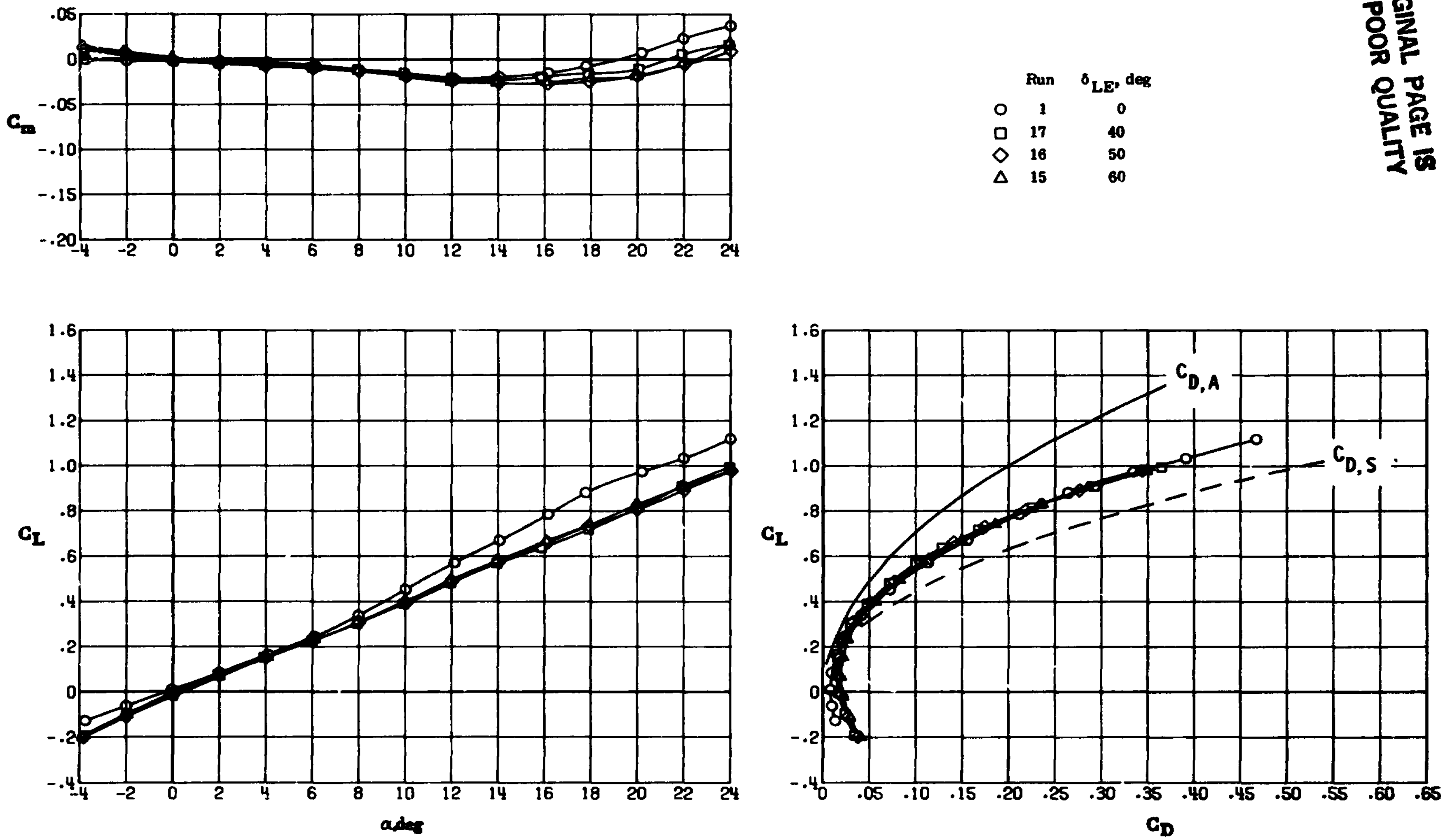

Figure 5.- Concluded.

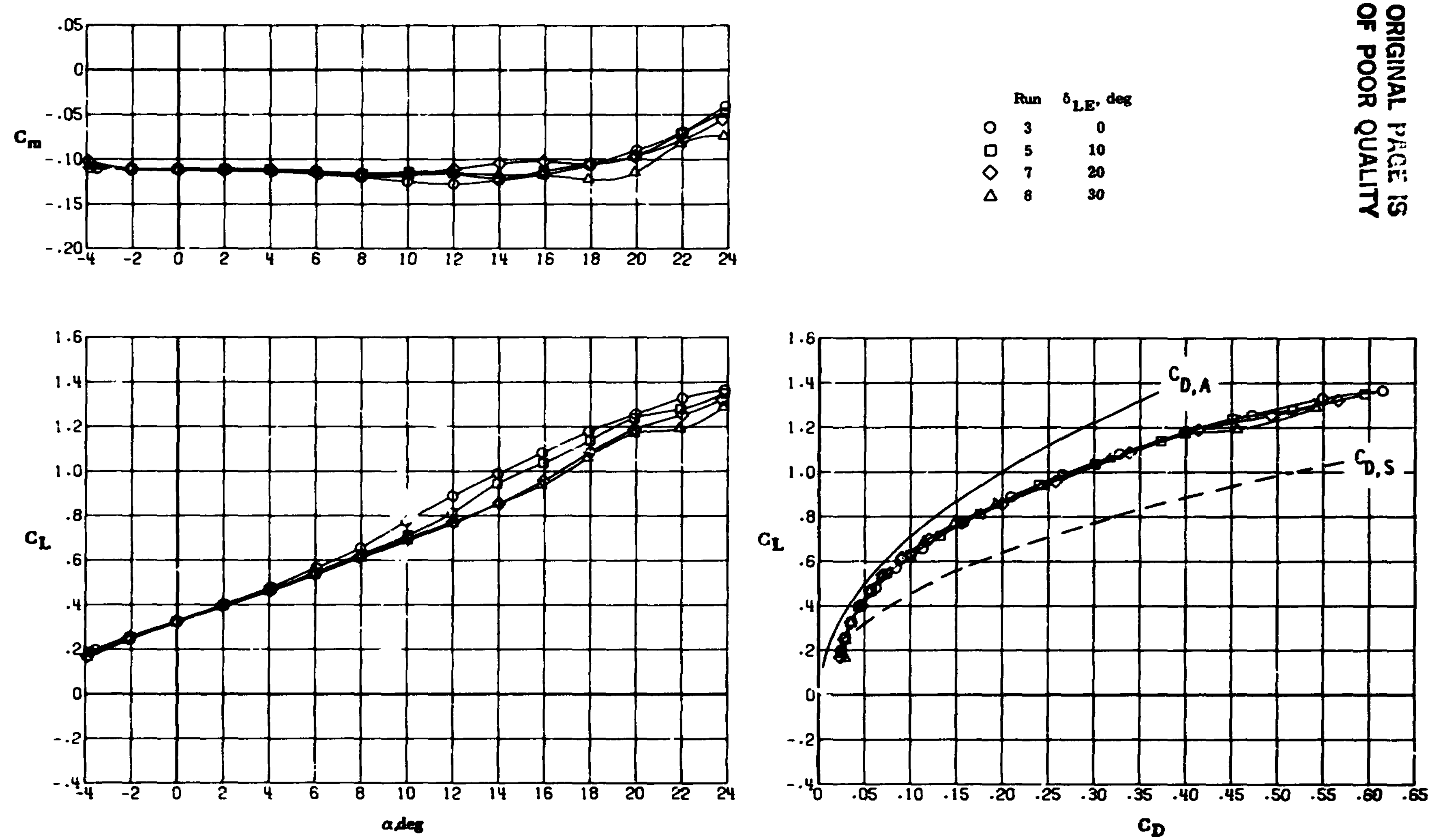

Figure 6.- Effect of leading-edge flap deflections on longitudinal aerodynamic characteristics with δ_{TE} = 20°.

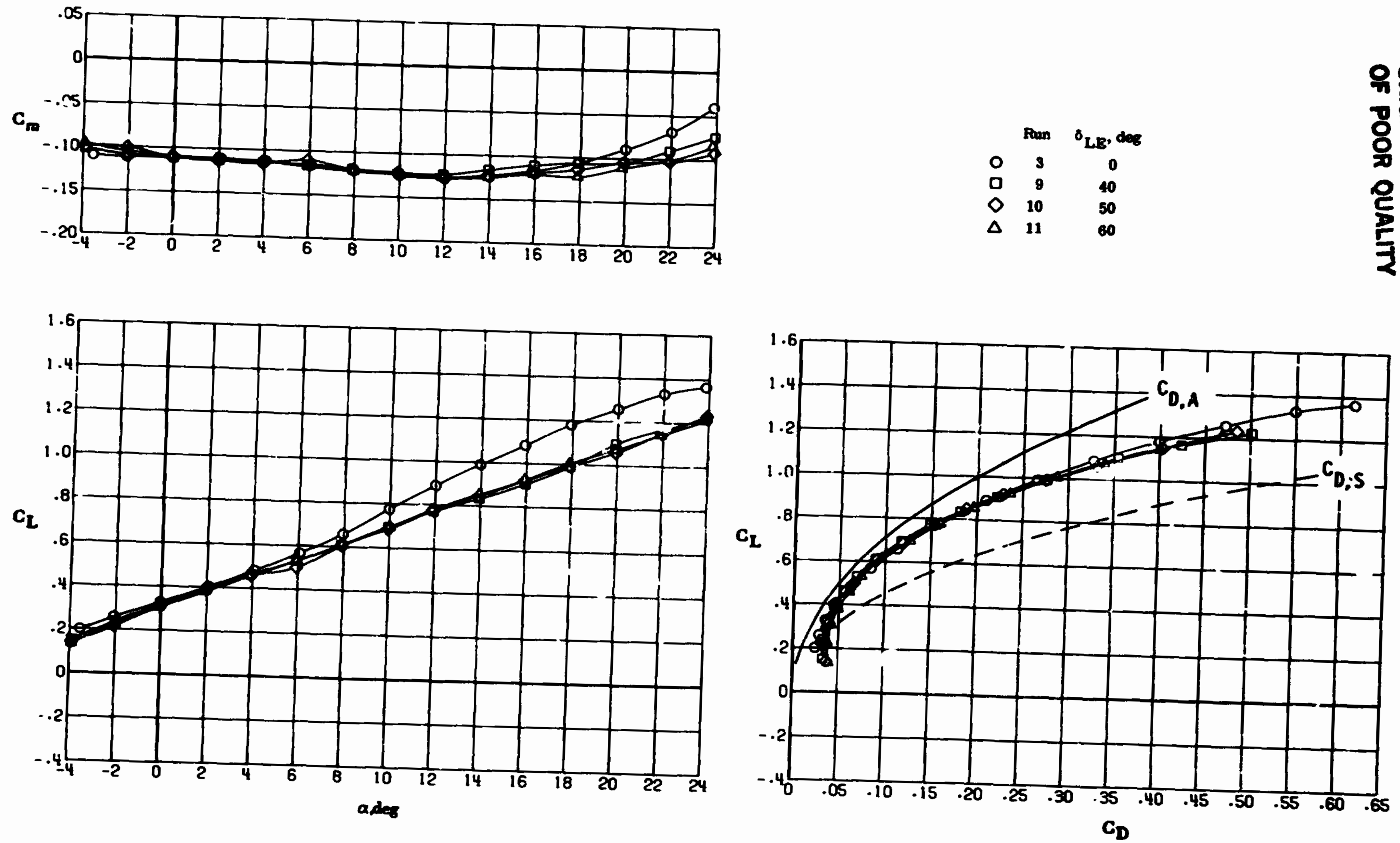

Figure 6.- Concluded.

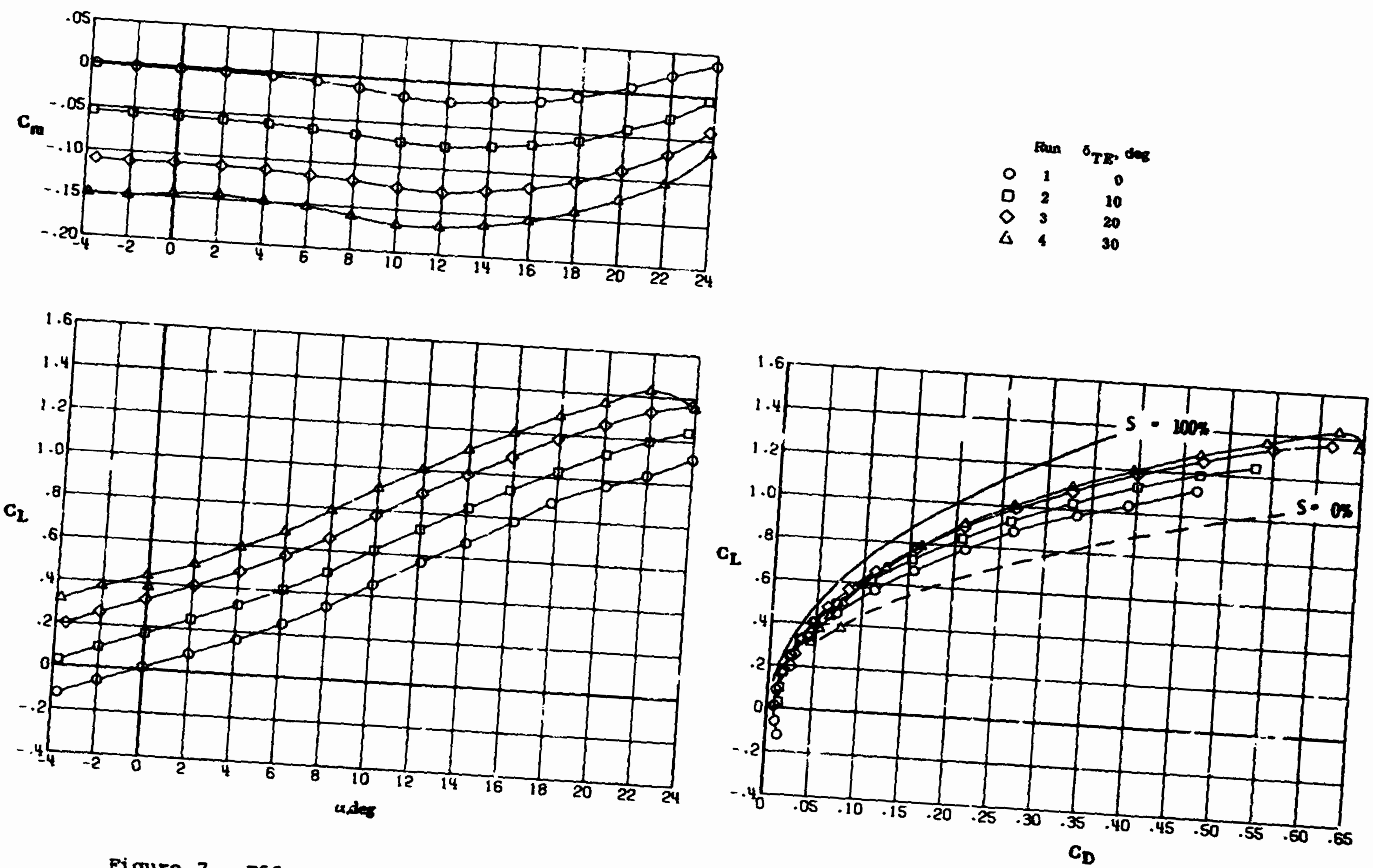

Figure 7.- Effect of trailing-edge deflections on longitudinal aerodynamic characteristics with $\delta_{LE} = 0°$.

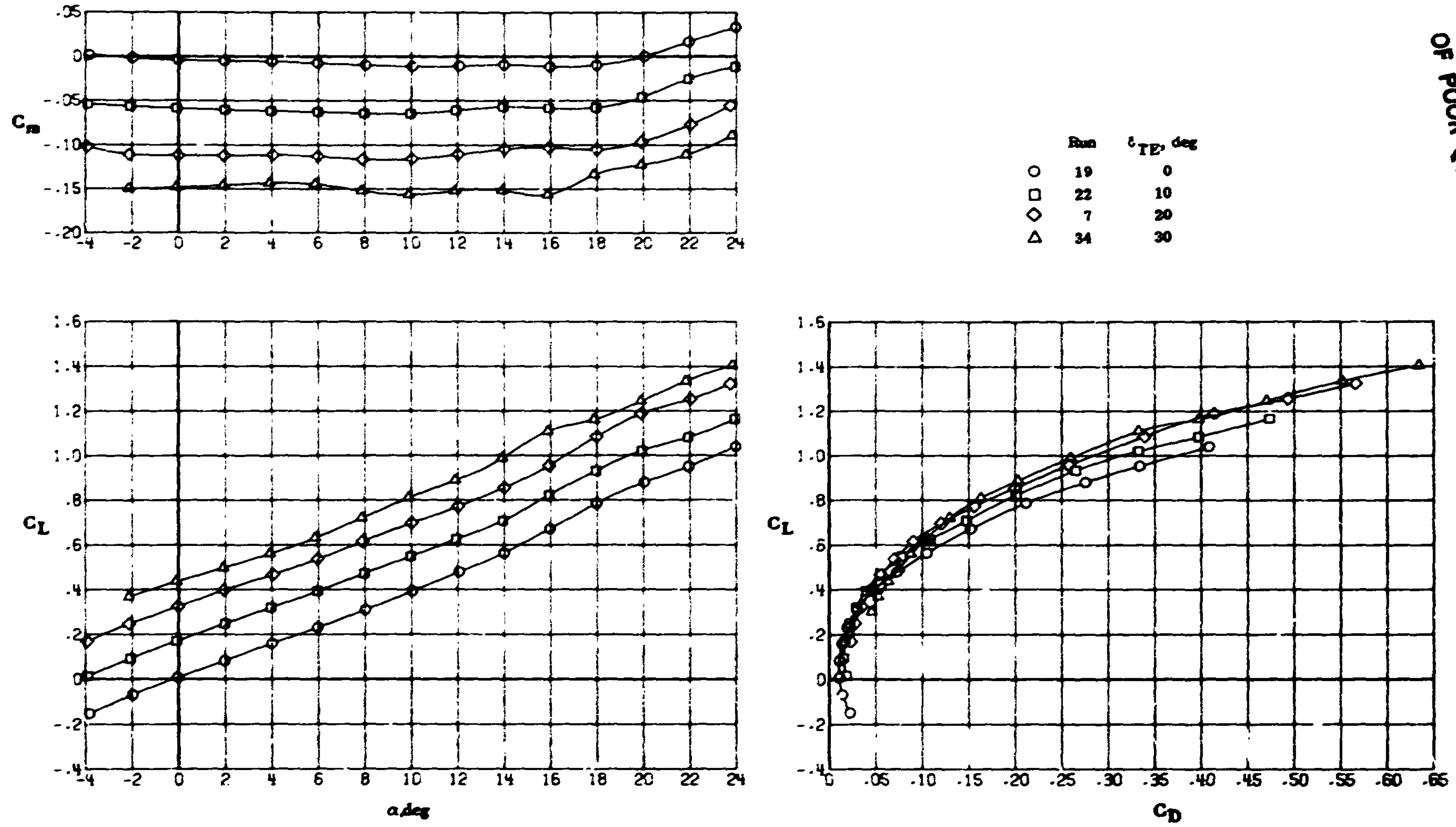

Figure 8.- Effect of trailing-edge deflections on longitudinal aerodynamic characteristics with δ_{LE} = 20°.

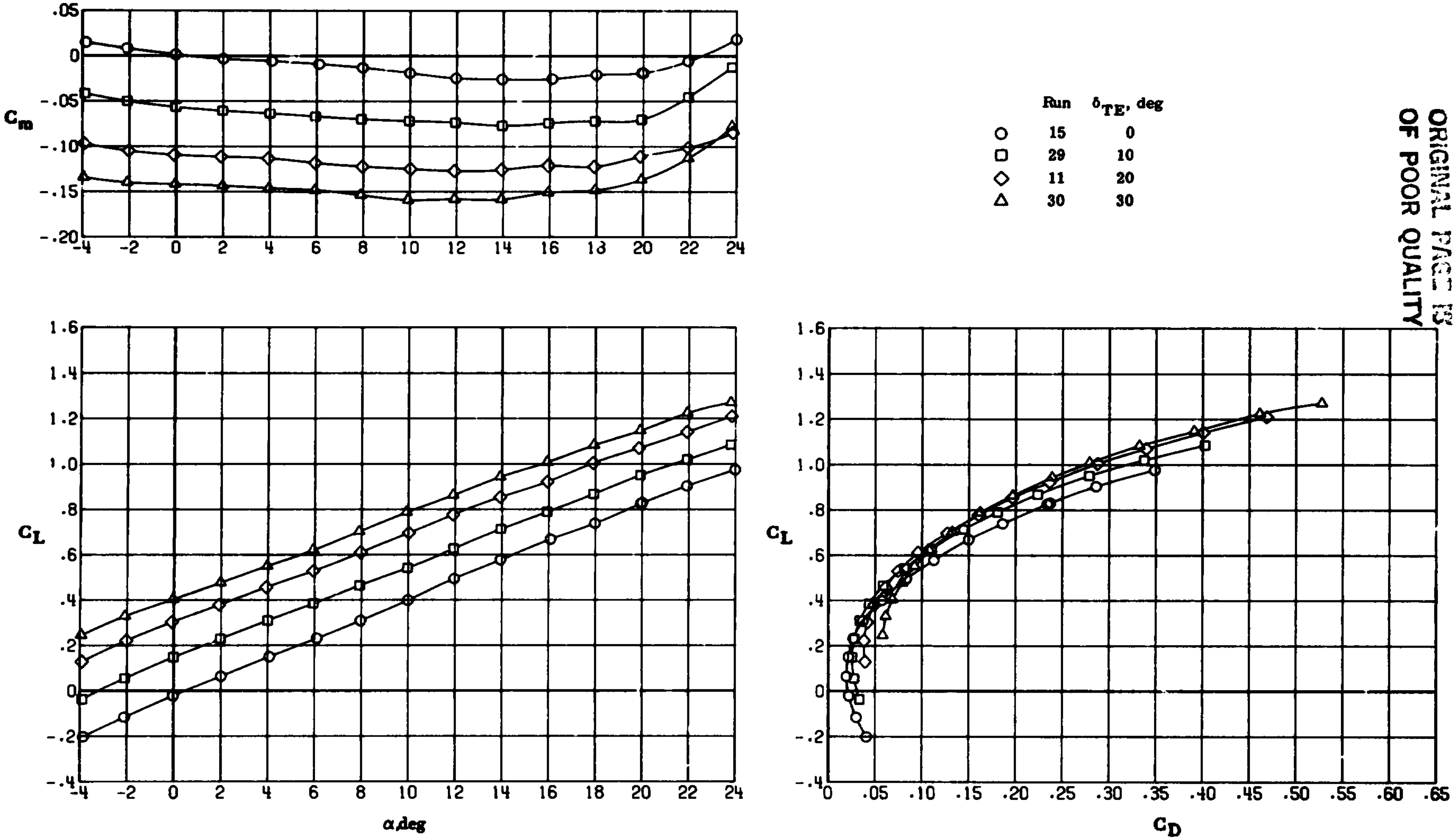

Figure 9.- Effect of trailing-edge deflections on longitudinal aerodynamic characteristics with $\delta_{LE} = 60°$.

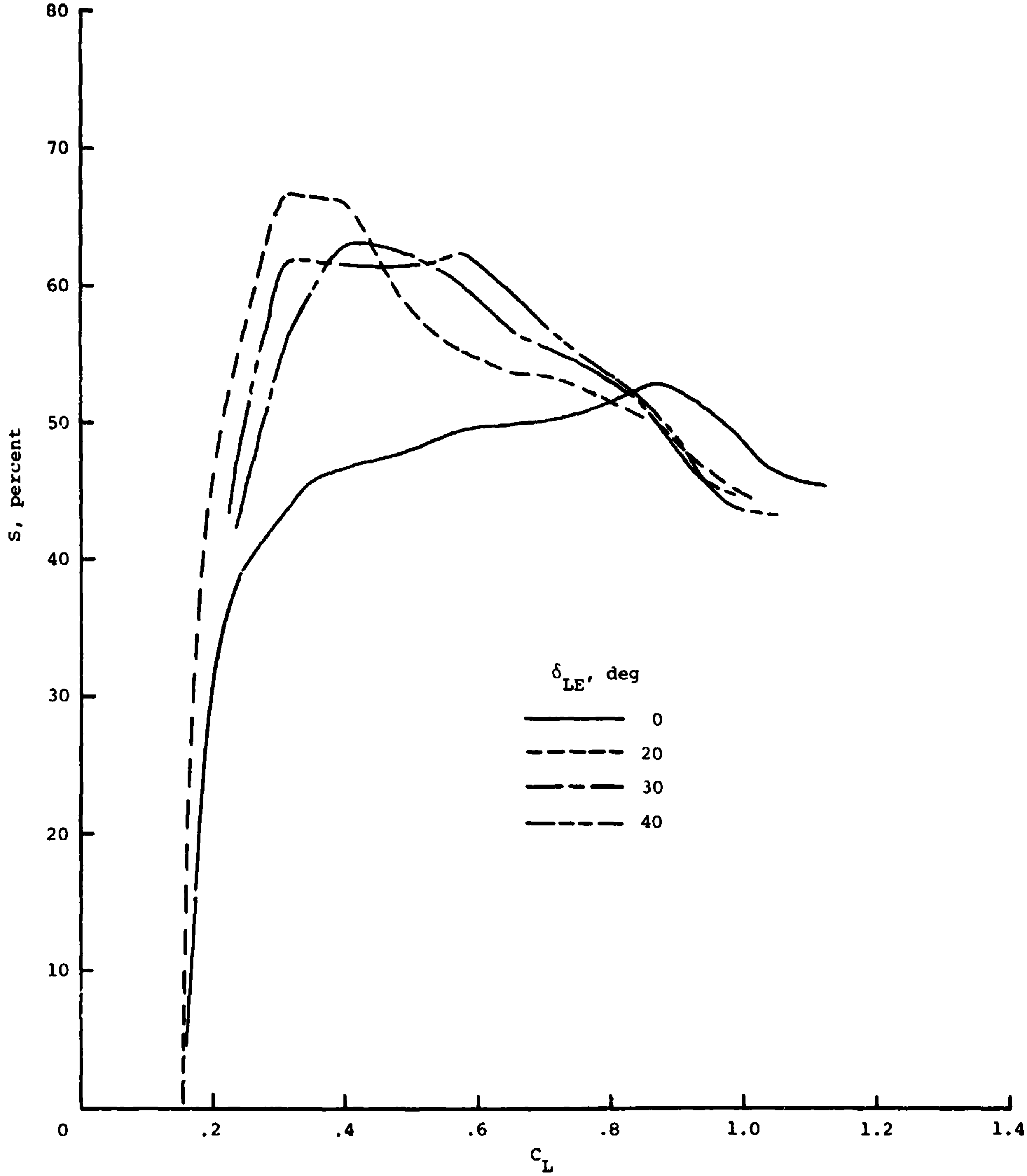

Figure 10.- Effect of variation of best leading-edge deflections on leading-edge suction parameter and lift coefficient with $\delta_{TE} = 0°$.

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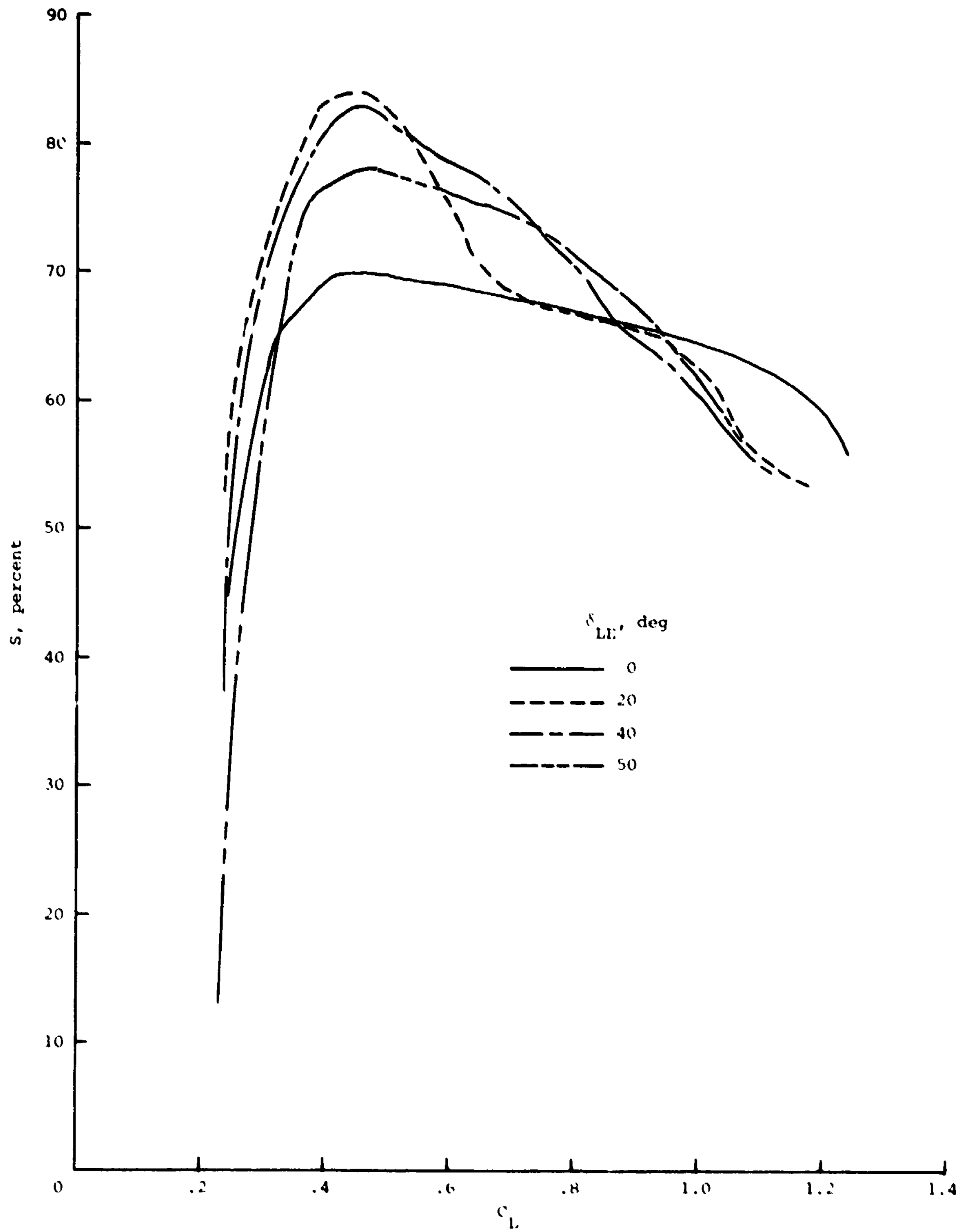

Figure 11.- Effect of variation of best leading-edge flap deflections on leading-edge suction parameter and lift coefficient with $\delta_{TE} = 10°$.

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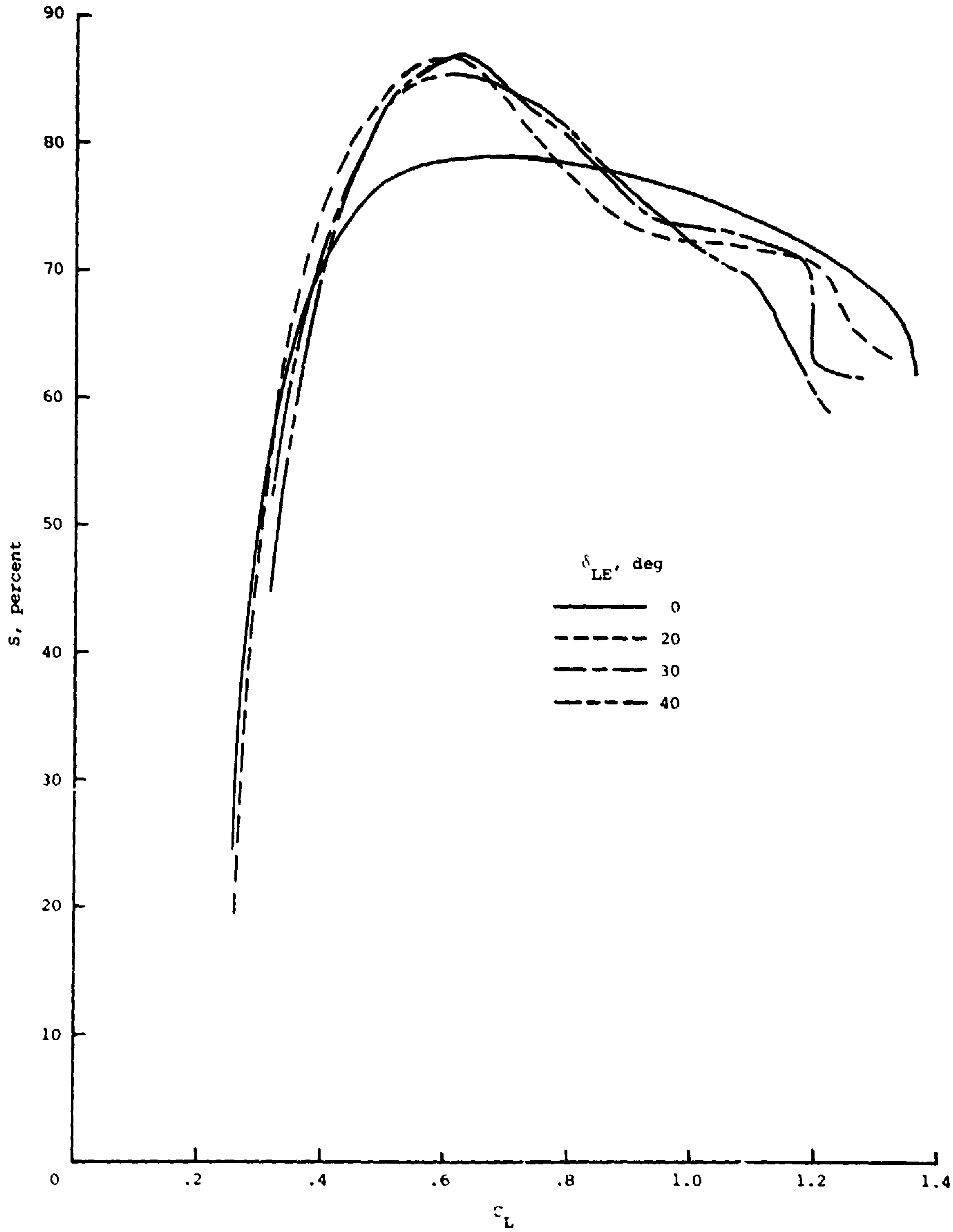

Figure 12.- Effect of variation of best leading-edge flap deflections on leading-edge suction parameter and lift coefficient with $\delta_{TE} = 20°$.

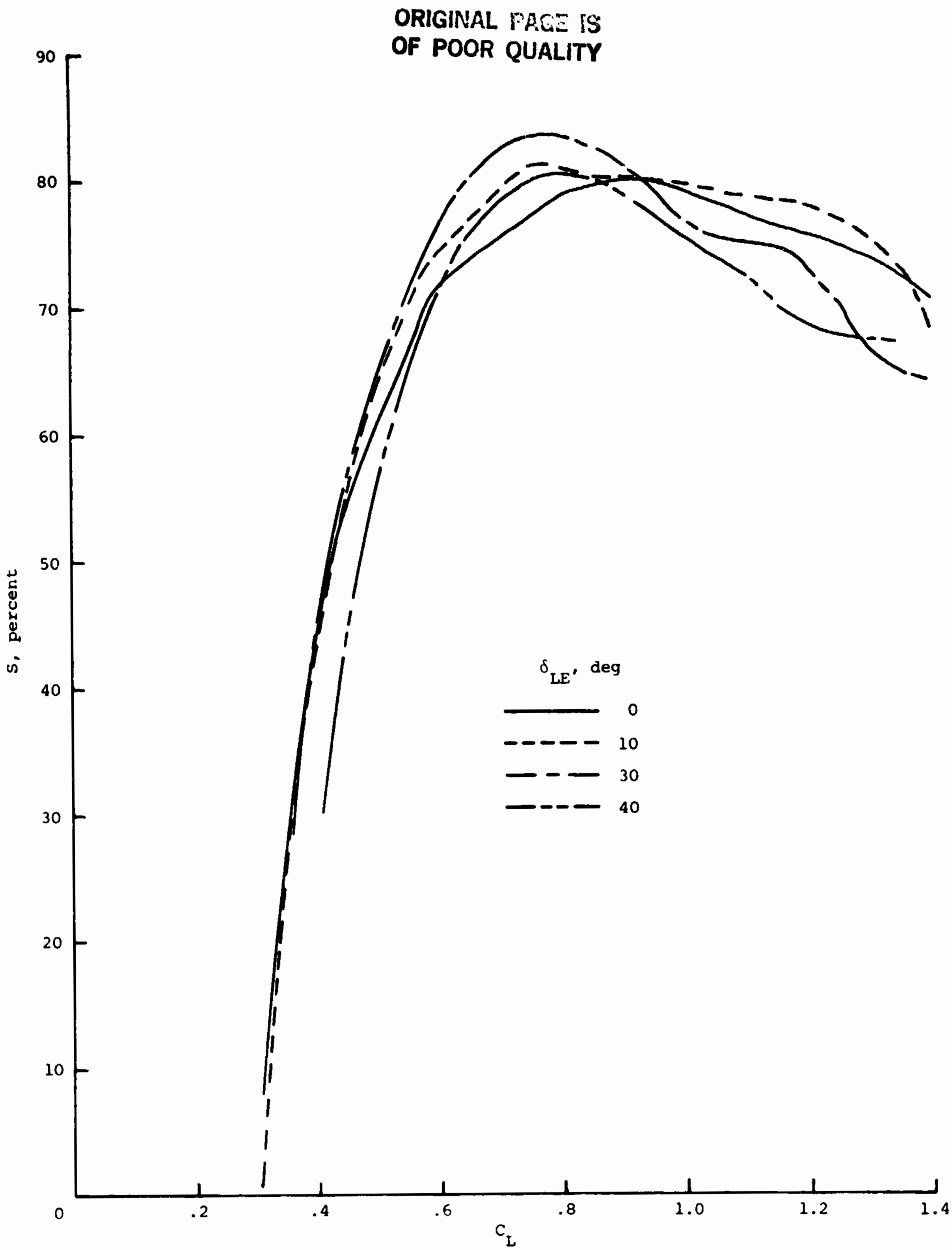

Figure 13.- Effect of variation of best leading-edge flap deflections on leading-edge suction parameter and lift coefficient with $\delta_{TE} = 30°$.

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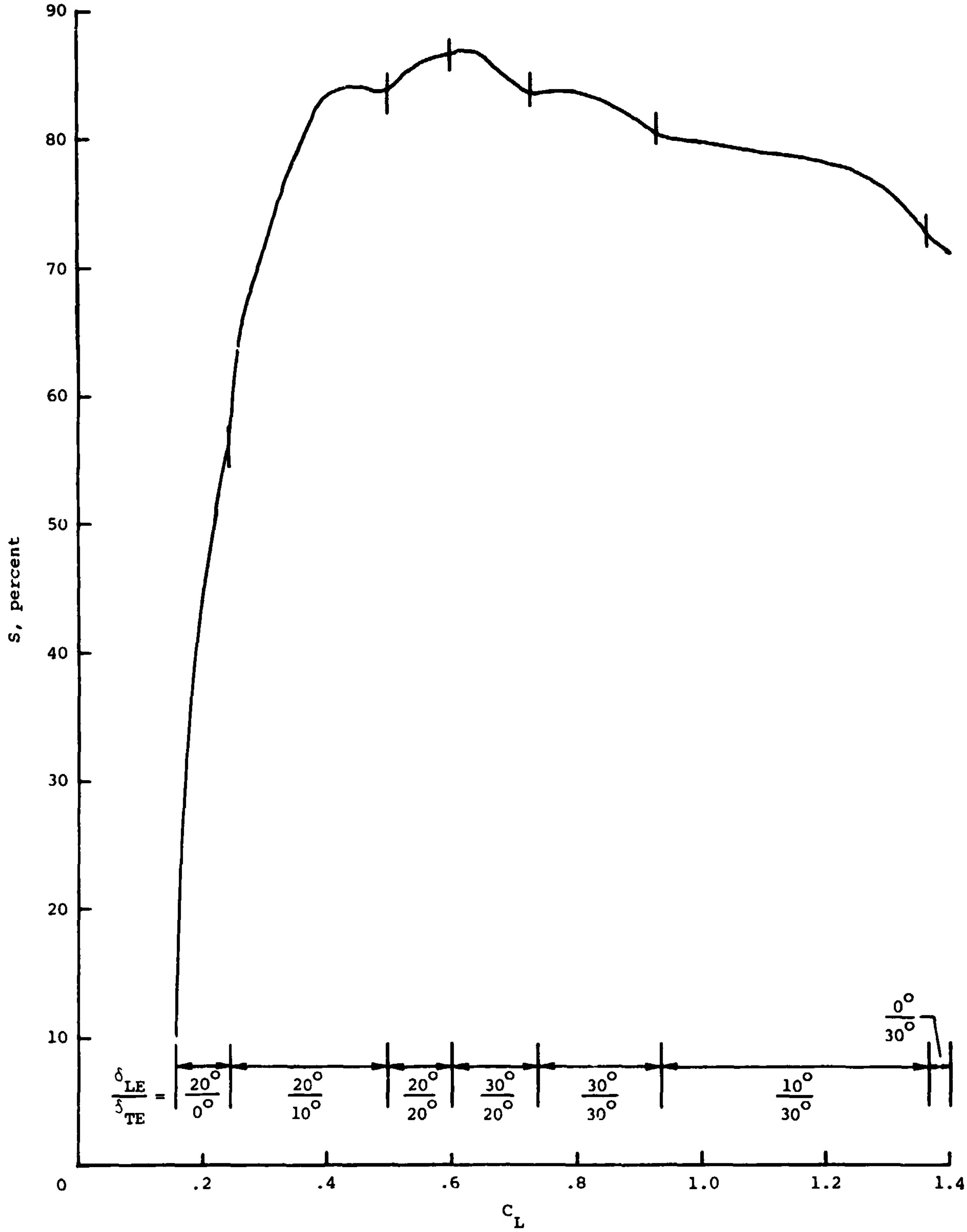

Figure 14.- Maximum values of leading-edge suction attainable through a combination of leading- and trailing-edge flap deflections.

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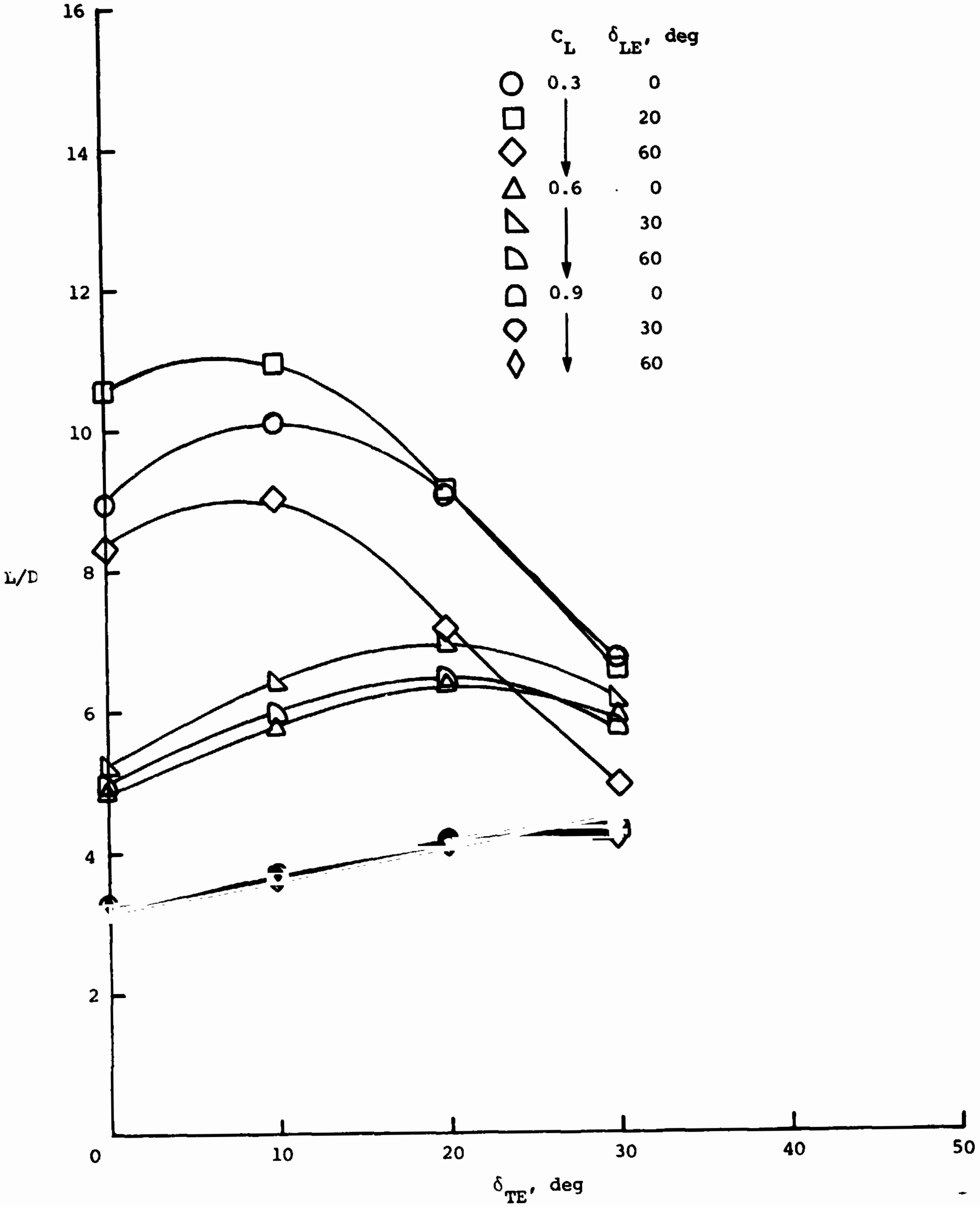

Figure 15.- Effect of trailing-edge deflection on L/D for various leading-edge deflections and lift coefficients.

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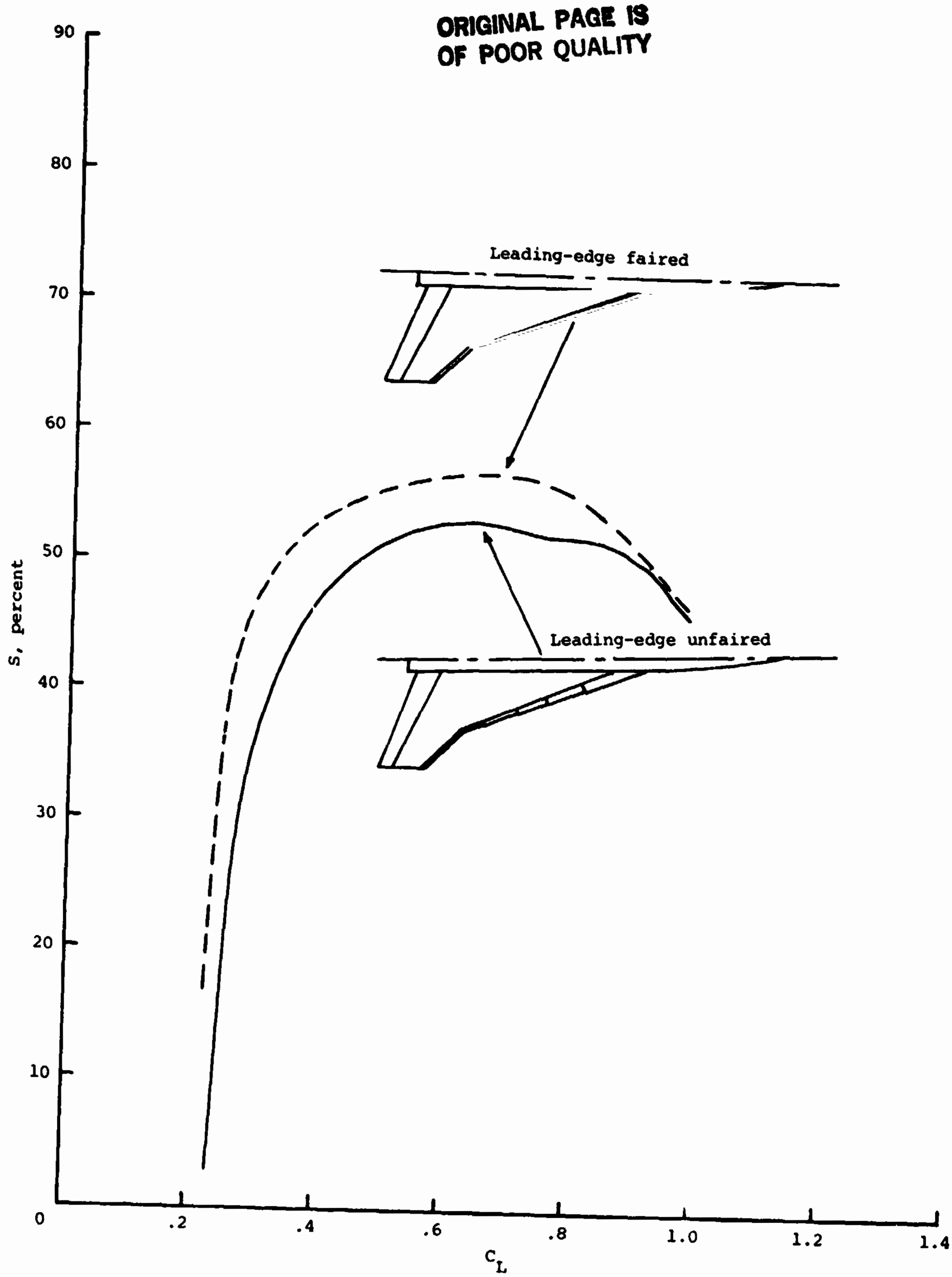

Figure 16.- Effect of fairing the leading edge with $\delta_{LE} = 60°$ and $\delta_{TE} = 0°$.

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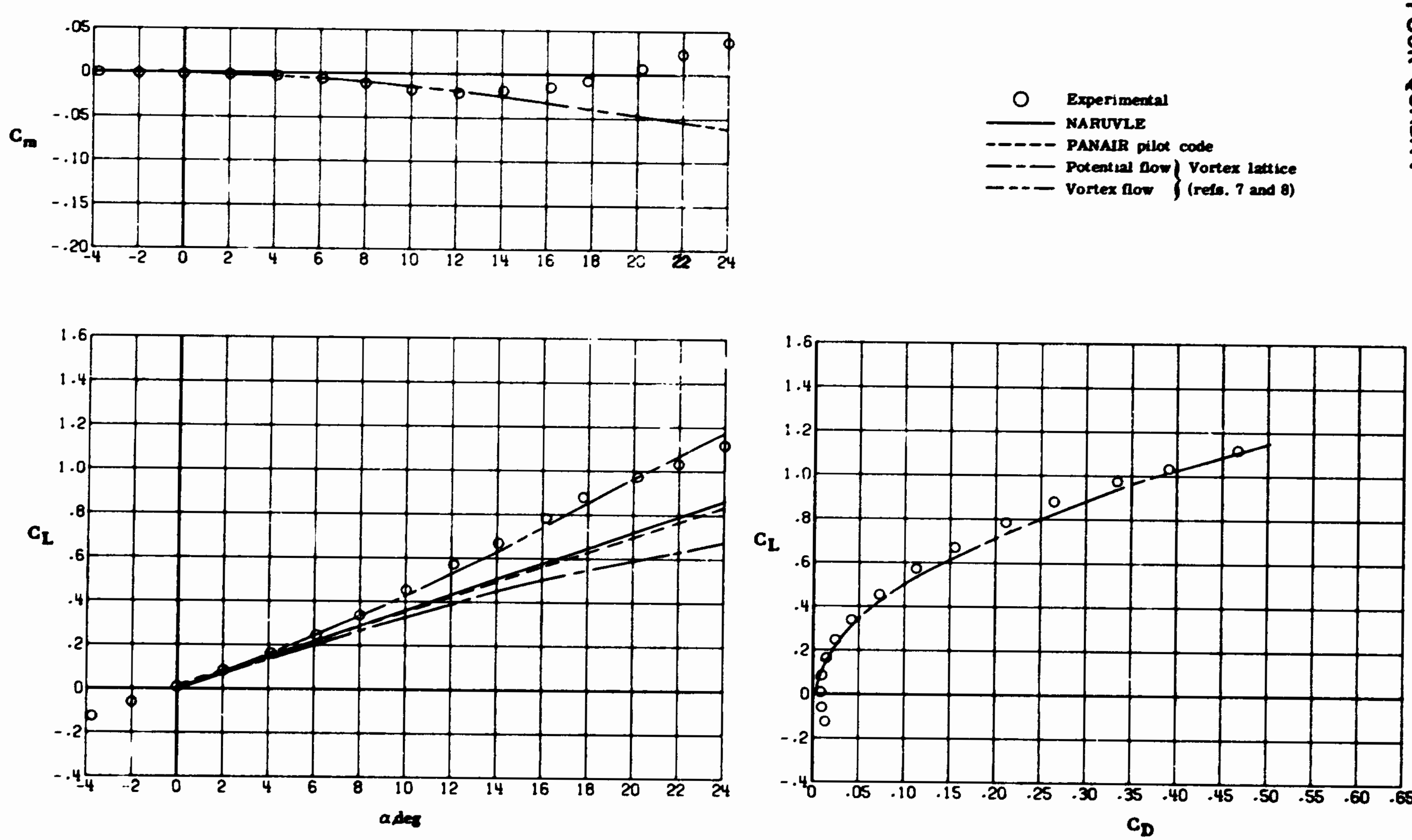

Figure 17.- Comparison of experimental data with $\delta_{LE} = 0°$ and $\delta_{TE} = 0°$.

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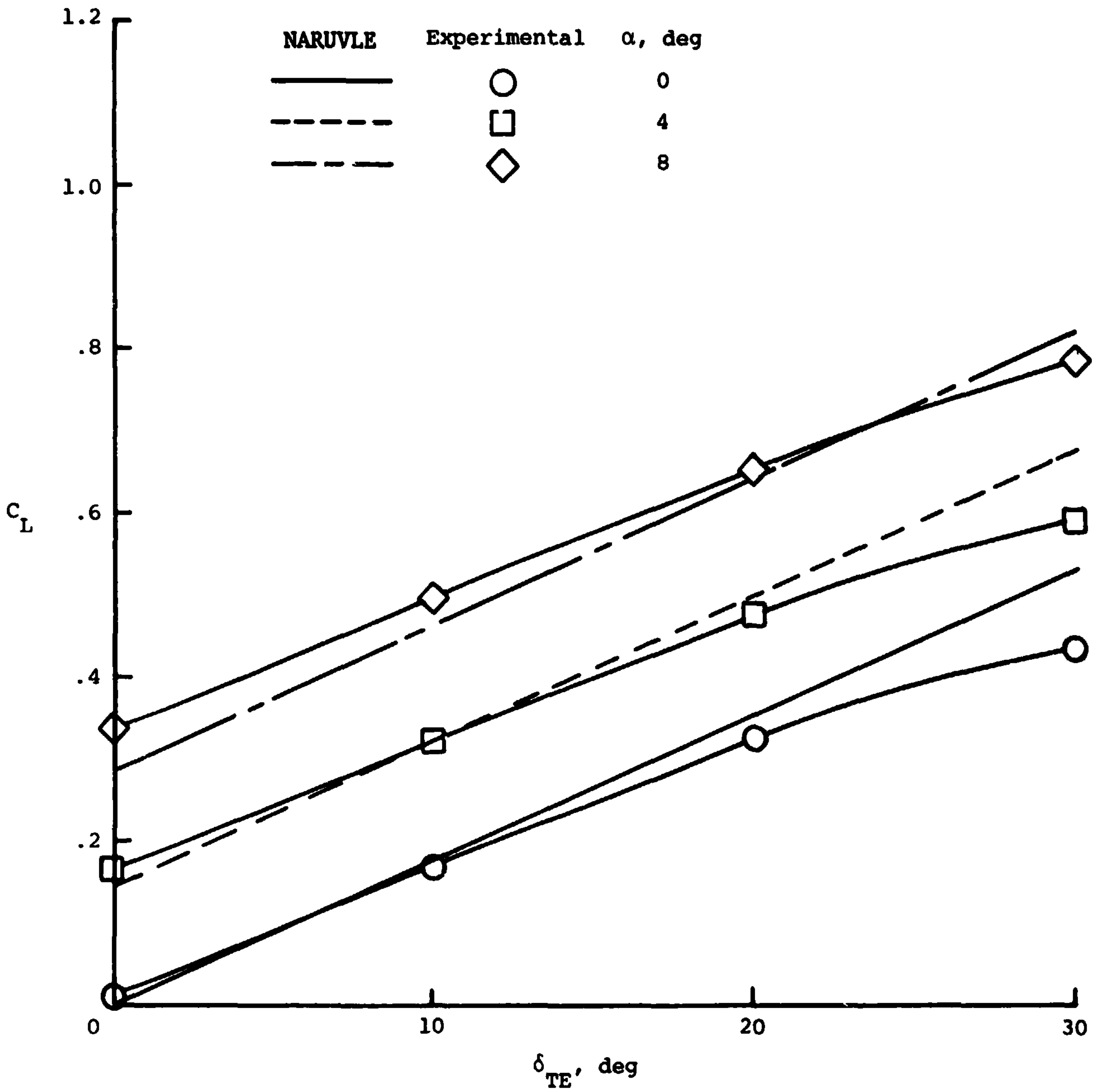

Figure 18.- Comparison of theoretical and experimental results on trailing-edge deflections and lift coefficient.